



# Space Science and Technology for the Benefit of Society

Dr. Pascal Michel, Canada

Preparatory Meeting for the High Level Forum

“Space as a Driver for Socioeconomic Sustainable Development”, November 19<sup>th</sup> 2015, Vienna, Austria

# Overview

- Science, technology and society
- Societal areas benefiting from space
- Space solutions
- Perspectives for the future

# SCIENCE AND POLICY



# Technology and human needs

*“Stop seeing the world through the lens of technology, and start seeing technology through the lens of deep human needs and wants”*

*David Mattin, Trendwatching.com*

business  
**life**

## **Fundamental human needs**

→ Subsistence – protection – affection – understanding - participation  
Leisure – creation – identity - freedom

# The World we live in - seven billion and counting

## A growing population

By 2025, world population will be over 8 billion people. Around 2040 it could hit 9 billion and by 2100 it could reach a massive 11 billion people.

## And a much bigger world economy

The world economy could grow a massive 26 times in this century. This will put enormous pressure on Earth's resources. And we are already overusing at 160 percent...

## Current World Population

# 7,378,171,709

[view all people on 1 page >](#)

### TODAY

Births today  
**207,690**

Deaths today  
**86,975**

Population Growth today  
**120,715**

### THIS YEAR

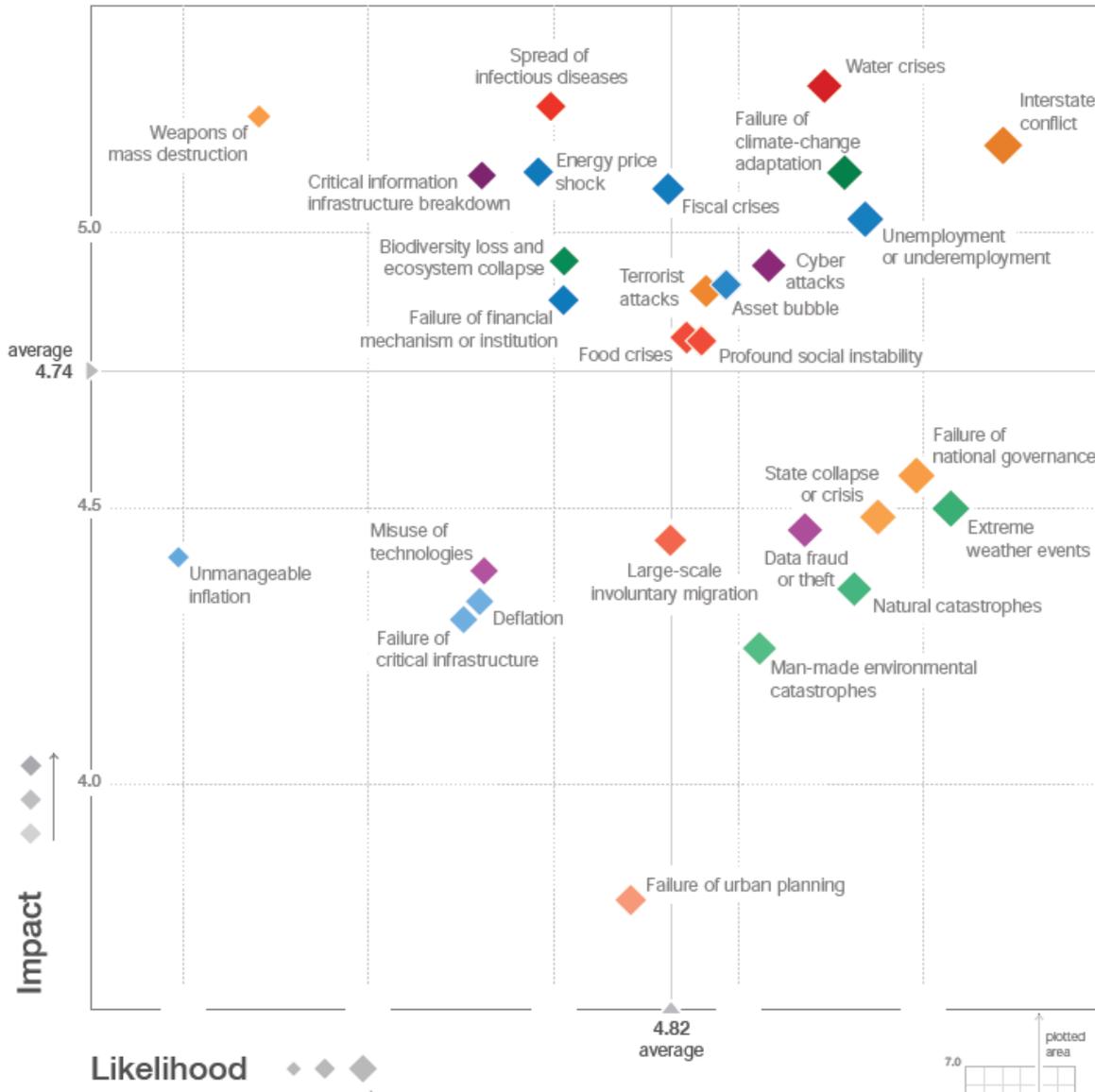
Births this year  
**119,806,242**

Deaths this year  
**50,171,586**

Population Growth this year  
**69,634,656**

On November 2<sup>nd</sup>, 2015

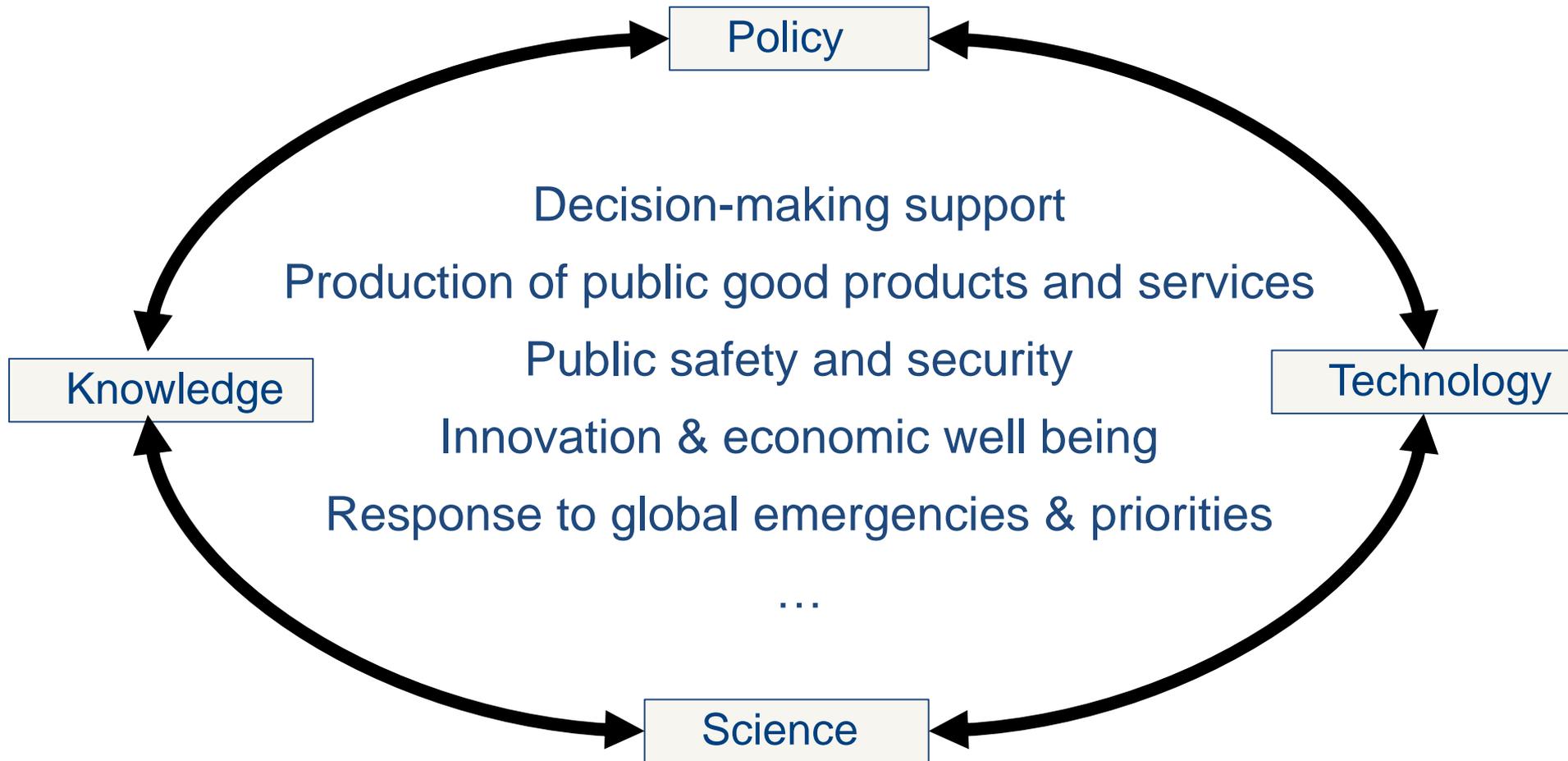
# Global risks landscape - 2015



## Trends 2015

- Aging population
- Climate change
- Environmental degradation
- Growing middle class
- Increasing national sentiment
- Increasing polarization of societies
- Rise of chronic diseases
- Rising of mobility
- Rising income disparity
- Shifts in power
- Urbanization
- Weakening of international governance

# Key roles of science in addressing societal risks



# Positioning space S&T in society

- Are the societal contributions of space S&T different than for other scientific domains?
- What are the key areas of our society benefiting from space activities?
- Are space S&T activities articulated through the lens of fundamental human needs?
- Do space initiatives provide worldwide solutions that transcend national borders?



# SOCIETAL AREAS BENEFITING FROM SPACE



# Societal benefits from space exploration

## Innovation

Contributed to many diverse aspects of everyday life (solar panels, heart monitors, cancer therapy) - an essential driver for opening up new domains in science and technology (materials, power generation, energy storage, waste management, advanced robotics, computing, miniaturization)

## Culture and inspiration

A unique perspective on humanity's place in the Universe - Fulfilling people's curiosity, producing fresh data about the solar system : What is the nature of the Universe? Is the destiny of humankind bound to Earth? Are we and our planet unique? Is there life elsewhere in the Universe?

## Addressing global challenges

A global endeavor contributing to trust and diplomacy between nations, advancing international preparedness on various issues such as asteroid strikes, space weather and space debris.

*“There is no activity on Earth that matches the unique challenges of space exploration”*



# Societal benefits from the International Space Station

## Human Health

Robotic arm for medicine - Preventing bone loss – Aging - Growing high-quality protein crystals - Research on asthma - vaccine development – Ultrasound – Immunology - Cancer treatment delivery – Supporting water purification – Eye surgery

## Earth Observation and Disaster Response

Monitoring water quality – Monitoring natural disasters - Supporting studies relevant to climate change - Keeping watch on the world's sea traffic

## Global Education

Inspiring youth - students fitness



[http://www.nasa.gov/mission\\_pages/station/research/benefits/index.html](http://www.nasa.gov/mission_pages/station/research/benefits/index.html)



# Societal benefits from international cooperation



A UN-COPUOS session



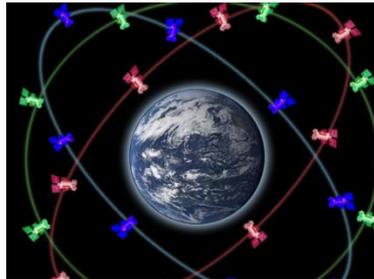
AT6 international workshop on global health and space



# Societal benefits from satellite services

## Civilian satellites

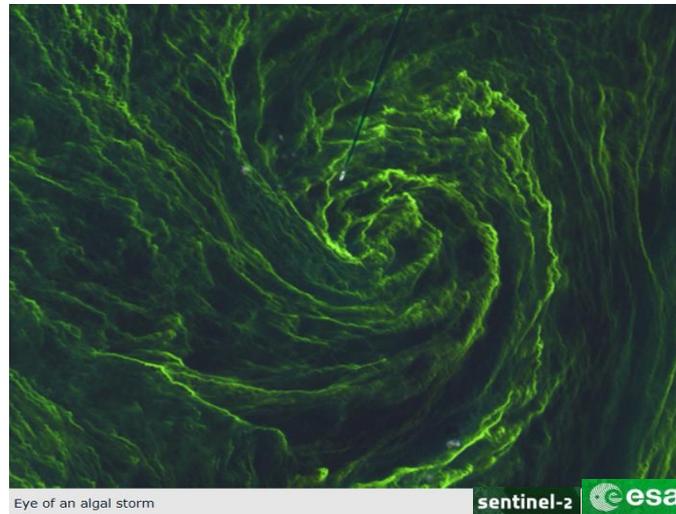
- Communications
- Navigation
- Earth Observation
- Astronomy



GLONASS constellation



Satellite Internet access via VSAT in Ghana



Echo of Light from Hubble

# SPACE SOLUTIONS



# Societal benefits from space exploration spinoffs



Fuel-cell engine



Biosensor to test for pathogens



Algae-derived ingredients



Water mapping technology



Eurobot Wet Model



Chlorophyll meters detecting plant stress



Magnetic fluids for speakers



IGAR - Image-Guided Autonomous Robot

# Societal benefits from satellite communications

Satellite communications are essential for:

- Television from geostationary satellites
- For education, health, development and safety goals in remote areas or areas lacking terrestrial infrastructures
- For communications in the high seas, for planes and ships
- Lifesaving services, emergencies, disasters and peacekeeping



satellite services and applications

→ A VITAL CORNERSTONE OF MODERN SOCIETY



# Some advantages of satellite communication services

- **Cost Effectiveness** - Satellite connection cost is distance insensitive.
- **Global Availability** - Communications satellites cover all land masses (including rural and remote regions).
- **Reliability** - Satellite communications can operate independently from terrestrial infrastructure.
- **Performance** - Satellite is unmatched for broadcast applications like television.
- **Scalability** - Satellite has proven its value as a provider of "instant infrastructure" for commercial, government and emergency relief communications.
- **Versatility** - Satellites effectively support on a global basis all forms of communications.

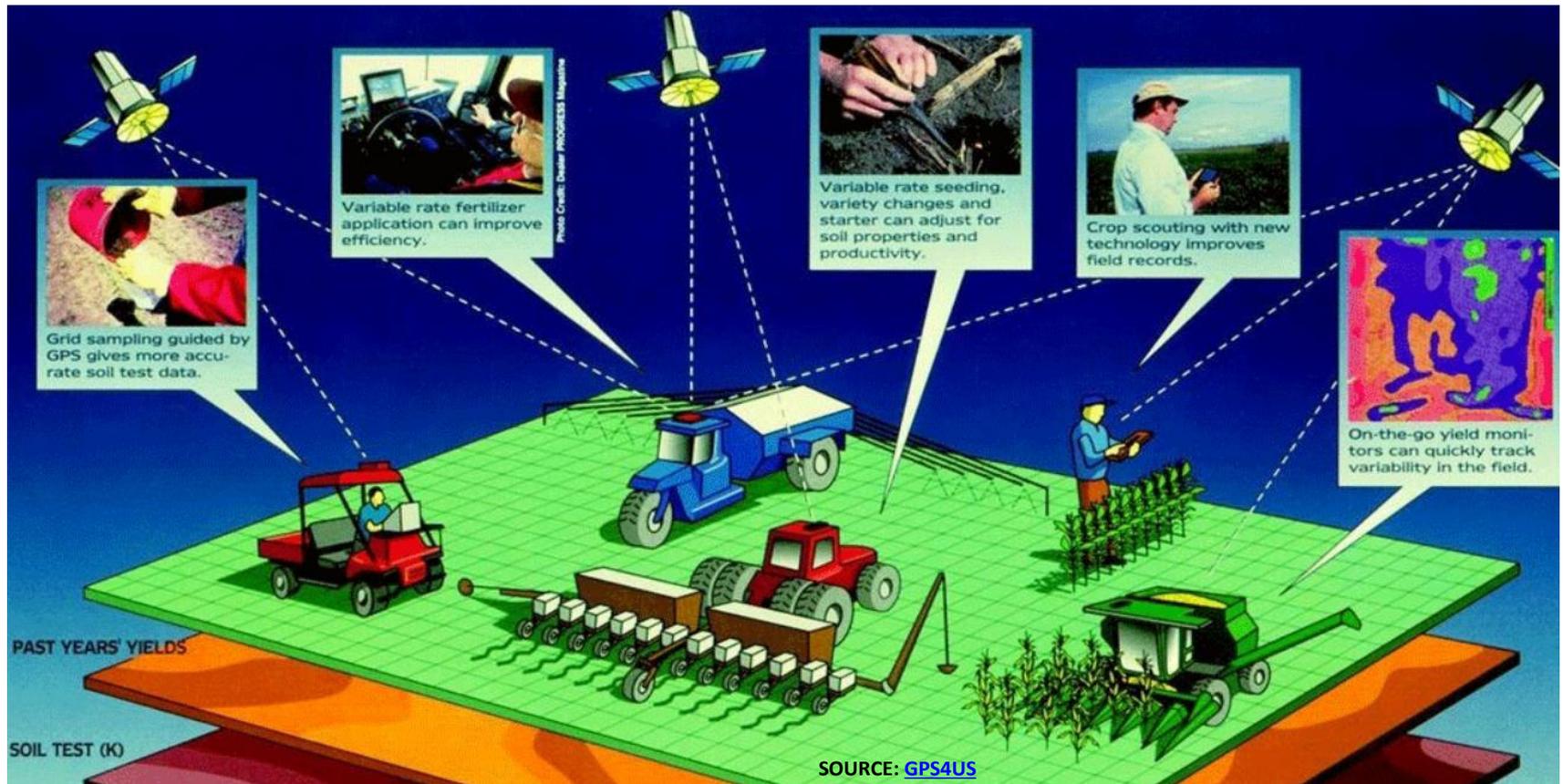
# Societal benefits from Earth observation



World Space Week 2014. © World Space Week Association, All Rights Reserved

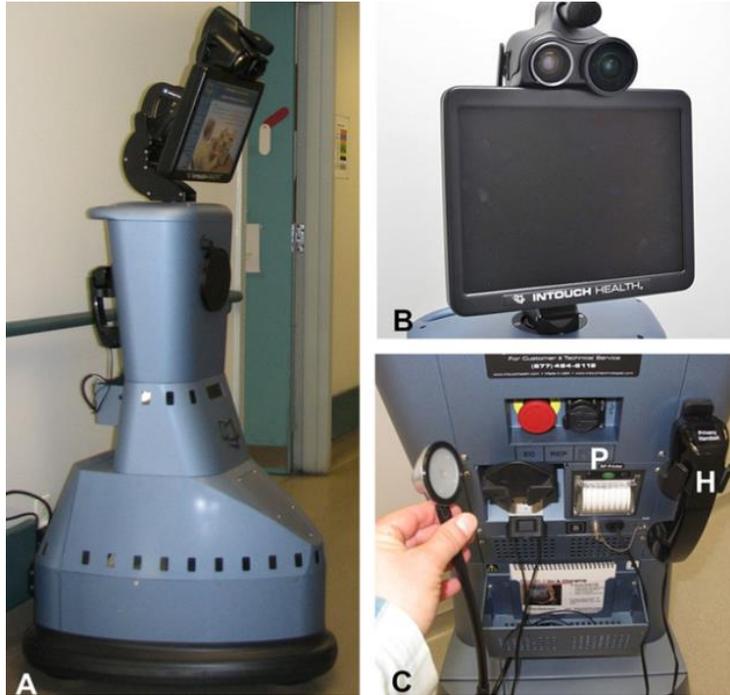
- **Disaster:** Reducing loss of life and property from natural and human-induced disasters
- **Health:** Understanding environmental factors affecting human health and well-being
- **Energy:** Improving management of energy resources
- **Climate:** Understanding, assessing, predicting, mitigating, and adapting to climate variability and change
- **Agriculture:** Supporting sustainable agriculture and combating desertification
- **Ecosystems:** Improving the management and protection of terrestrial, coastal and marine resources
- **Biodiversity:** Understanding, monitoring and conserving biodiversity
- **Water:** Improving water-resource management through better understanding of the water cycle
- **Weather:** Improving weather information, forecasting and warning

# Example – precision agriculture



A farming management concept based on observing, measuring and responding to inter and intra-field variability in crops

# Example – telemedicine

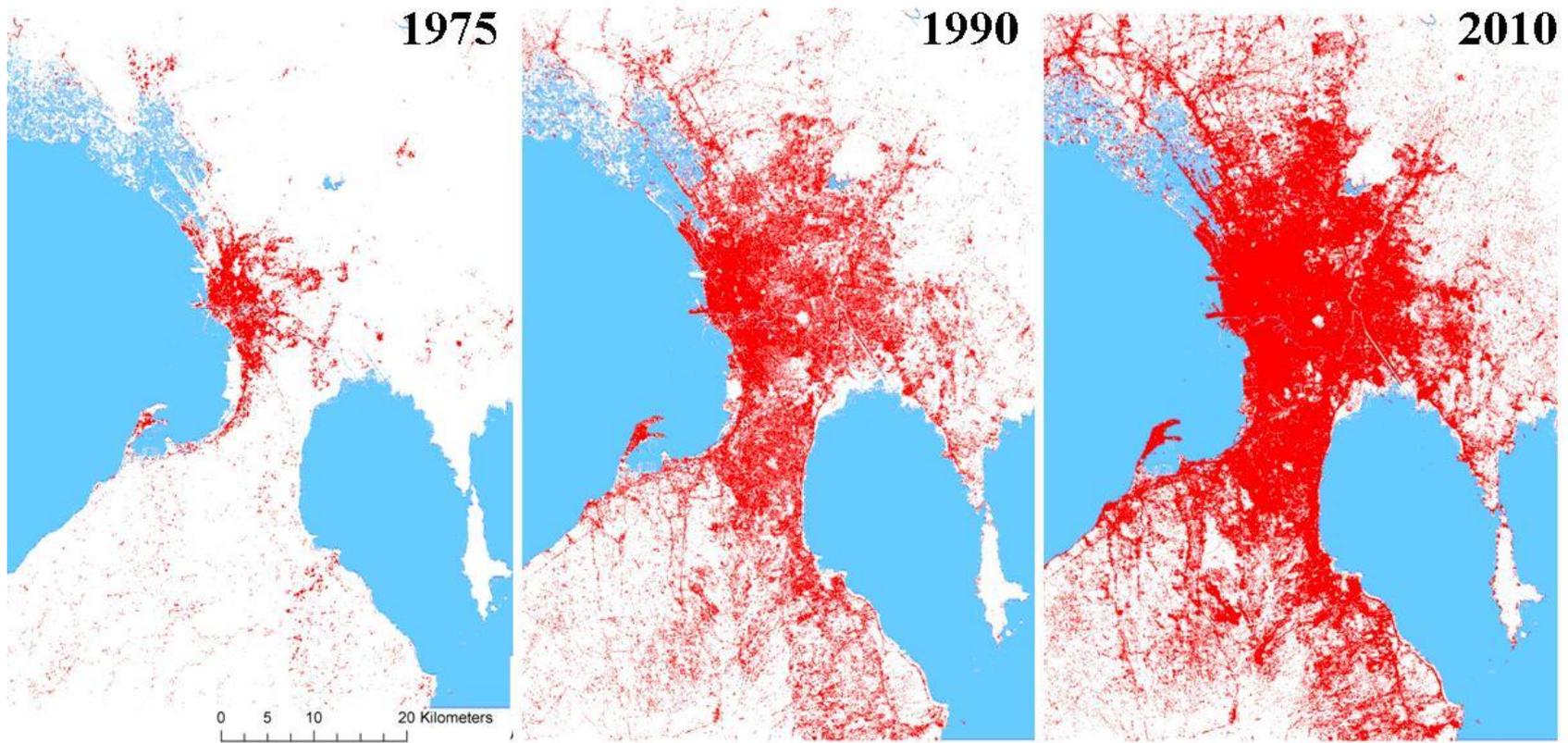


*"Doctor in a Box"*

## 5 ways robots are delivering health care in Saskatchewan

Dr. Ivar Mendez says robotic and portable devices represent start of 'revolution' in health system

# Example – urban growth

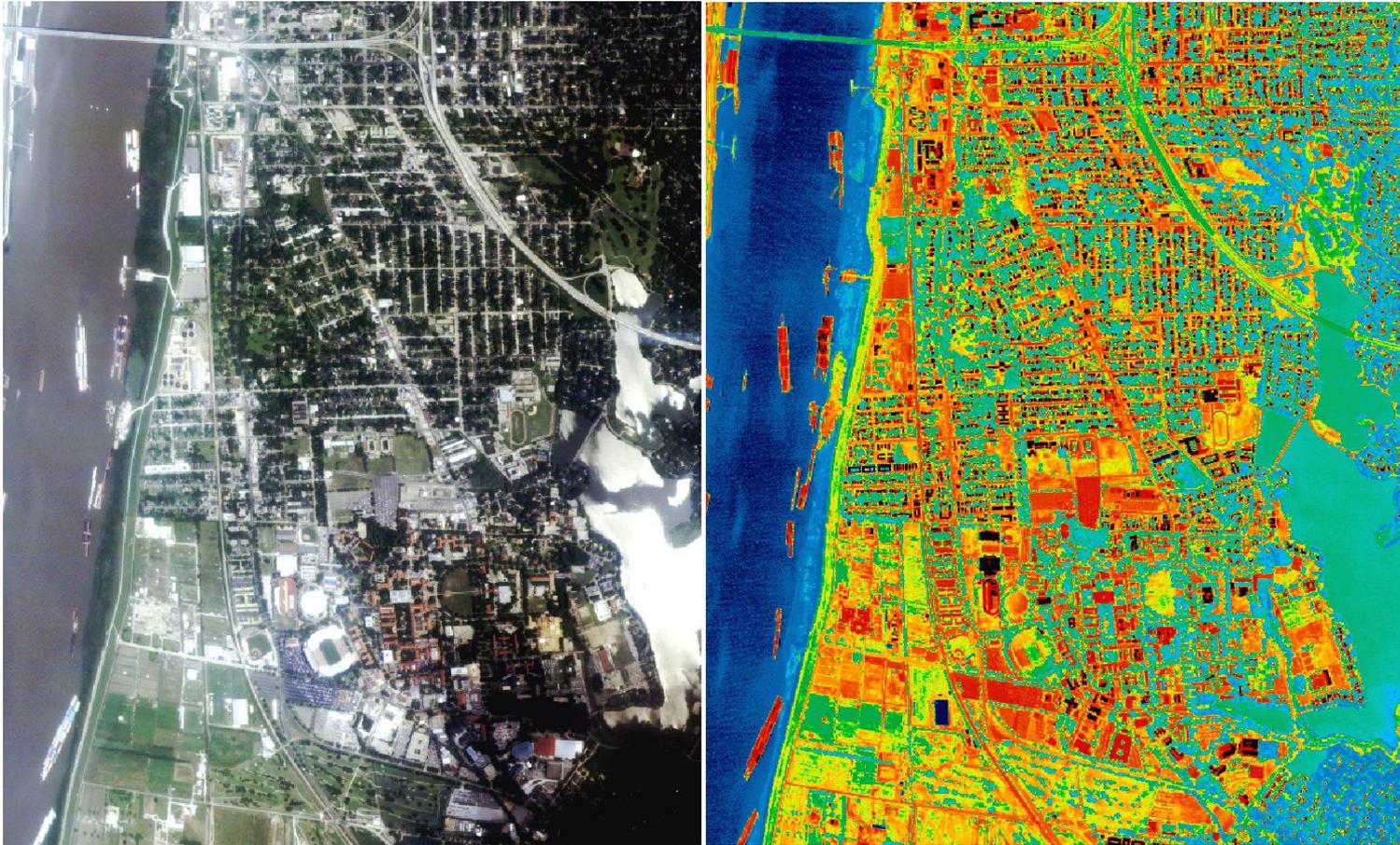


Remote Sensing – An Effective Data Source for Urban Monitoring

Multi-sensors urban growth analysis – by the example of Manila, Philippines. Source: DLR-DFD

<http://earthzine.org/2011/07/20/remote-sensing-an-effective-data-source-for-urban-monitoring/>

# Example – climate change and heat island



- An urban heat island (UHI) is a city or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities
- Baton Rouge: The yellow and red areas are hot, and generally correspond with roads and buildings; blue and green areas are cool and indicate water and vegetation. The solid blue swatch of color flowing down the left side is the Mississippi River.

[http://weather.msfc.nasa.gov/urban/urban\\_remote\\_sensing.html](http://weather.msfc.nasa.gov/urban/urban_remote_sensing.html)

# Example – forest fires and public security



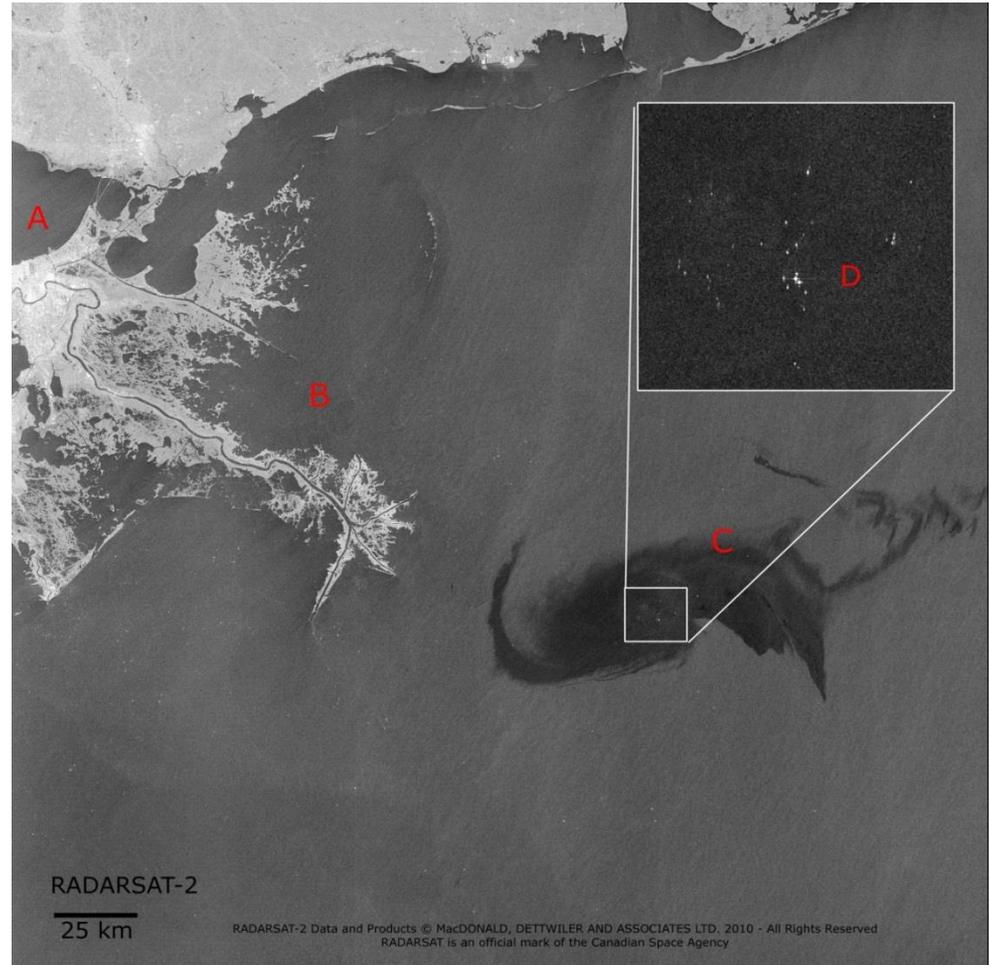
**SPOT 6 Satellite Image - Fire in Yosemite National Park, USA**

<http://www.geo-airbusds.com/en/5750-image-gallery-search-results?world=1184>

# Example – oil spill monitoring



<http://www.miros.no/products/oil-spill-detection/>



An oil platform located 70 km from the coast of Louisiana sank on Thursday April 22, 2010 in the Gulf of Mexico spilling oil into the sea. On these two RADARSAT images we can clearly see the evolution of the spill, which has a darker tone than the surrounding water, as well as some boats in the area. A: New Orleans, Louisiana; B: Delta of the Mississippi River; C: Oil slick; D: Close-up of ships and equipment

<http://www.asc-csa.gc.ca/eng/satellites/radarsat2/featured-image/featured-south-america.asp>

# Example – deforestation



[http://kids.mongabay.com/lesson\\_plans/lisa\\_algee/deforestation.html](http://kids.mongabay.com/lesson_plans/lisa_algee/deforestation.html)

**Amazon Deforestation**



July 20, 2000



August 21, 2009

The state of Rondônia in western Brazil is one of the most deforested parts of the Amazon. This MODIS series shows the deforestation that took place on the frontier in the northwestern part of the state between 2000 and 2008. Credit: NASA Earth Observatory

[http://www.nasa.gov/mission\\_pages/NPP/news/new-era.html](http://www.nasa.gov/mission_pages/NPP/news/new-era.html)

# Example – humanitarian aid

Providing **up-to-date, targeted**  
and **reliable** information on ...

(1) population numbers and densities



(2) potential groundwater reservoirs



(3) impact on the local environment



Andreas Papp, Program director, MSF, ESPI presentation, 2015

# Example – environmental risk assessment

HUMAN EVOLUTION/GLOBAL BIOETHICS

Vol. 27- n.1-3 (59-64) - 2012



Institute for Water, Environment and Health



UNITED NATIONS  
UNIVERSITY

Kotchi S. O. <sup>1,2</sup>

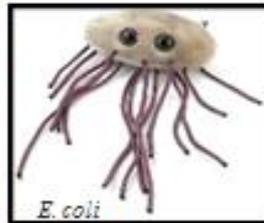
*Serge-Olivier.Kotchi@phac-aspc.gc.ca*

Turgeon P. <sup>1,2</sup>

*Patricia.Turgeon@phac-aspc.gc.ca*

## Assessing and Monitoring Microbiological Quality of Surface Waters Using Tele-Epidemiology

Evaluate the usefulness and the added value of remote sensing data as a component of the surveillance and management of microbial risk associate with recreational waters.



# Example – fighting poverty

HEALTH POLICY AND PLANNING; 13(4): 408–416

© Oxford University Press 1998

## Research reports

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### **Ecological and geographic characteristics predict nutritional status of communities: rapid assessment for poor villages**

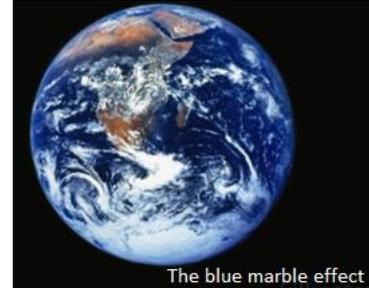
AGUSTIN KUSUMAYATI<sup>1,2</sup> AND RAINER GROSS<sup>2,3</sup>

*<sup>1</sup>Faculty of Public Health, University of Indonesia, Jakarta, Indonesia, <sup>2</sup>SEAMEO-TROPMED Regional Center for Community Nutrition, University of Indonesia, Jakarta, Indonesia, and <sup>3</sup>Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Germany*

The quality of poverty alleviation programmes relies heavily on appropriate targeting and priority setting. Major problems in assessing poverty include identification of the indicators of poverty and the methods used for its assessment. Nutritional status, expressed by anthropometric indices, has been proposed as a poverty indicator because of its validity, objectivity, reliability and feasibility. **This study was conducted to explore the application of remote sensing to poverty mapping** based on nutritional status at the community level. Relationships between the nutritional status within a

# Societal benefits - inspiration

Space activities, as a societal driver...



The blue marble effect

- To search for extra terrestrial life
- For economic development - For unified view of the World
- Of freedom, peace and progress - For future benefits such as space tourism
- To help solve challenges facing humanity
- To build a global system of space services - For International cooperation
- For technology spin-offs - Contributing to security and defense goals
- Contributing to solutions to the World problems - To change fundamental frames of space and time
- To enhance our safety through technology - Changing the way the World sees the people in need
- For a source of technology spin-offs - Allowing special research such as microgravity studies
- That speeds up the change in traditional technology fields - For positive progress
- For fostering kids interest in science and technology - To broaden consciousness on the limited capacity of our planet
- For the creation of a global connected village - Enabling different countries to work together for scientific gain
- Opening-up new avenues for sustainable development - To discover connectedness and the benefit or working together
- Bringing hope to explore other Worlds - To perform experiments that would be not possible on Earth
- Promoting a global culture - Impacting social progress, people lives and national strength
- To give us a glimpse at the future - Of improvement in living standard, safety and sciences
- For providing a future that we can get excited about - For ALL sciences
- Of solutions that affects our lives every day - To support science as a global good to all nations
- To give us another perspective at our own world - To generate new directions in science
- To foster innovation - To bridge gaps between cultures and societies
- Enhancing our ability to act on our planet - To improve the human condition
- For access to communication in some remote areas
- For the advancement of international law
- Enabling globalization - To give us a long term vision
- For a limitless future for humans



# Illustration – space art

"Space art" (also "astronomical art") is the term for a genre of modern artistic expression that strives to show the wonders of the Universe. Like other genres, space art has many facets and encompasses realism, impressionism, hardware art, sculpture, abstract imagery, even zoological art.



# PERPSECTIVE FOR THE FUTURE



# Conclusion – looking up to space

## Space exploration:

- Enabling a wide array of spinoffs products and innovation for general or specialized applications on Earth and a powerful instrument of promotion of basic sciences for the advancement of humanity
- Considerations towards further translation and active integration of space innovative technologies into other societal domains

### Fundamental human needs



Subsistence – protection – affection – **understanding** - participation  
Leisure – creation – **identity - freedom**

# Conclusion – providing societal services

## Services from satellites:

- Touching nearly all societal domains, yet critical to specific areas
- Enabling the provision of an impressive array of services
- Unique potential for enhanced applications towards global development and global security challenges (for the global public good)

### Fundamental human needs



**Subsistence – protection** – affection – **understanding - participation**  
**Leisure** – creation – identity - freedom

# Conclusion – fostering a global capacity

## Cooperation and policy perspectives:

- Balancing efforts towards responding to fundamental human needs vs. other needs
- Articulating priorities in supporting development goals, providing humanitarian assistance and contributing to solution to tangible global challenges
- Further enhancing cohesive approaches among United Nations organizations and other International capacities to enable effective leadership
- Consideration for promoting principles of relevance, coherence, sustainability and global perspective