United Nations | Department of Economic and Social Affairs

UNDRR
UN Office for Disaster Risk Reduction

Risk-informed Governance and Innovative Technology for Disaster Risk Reduction and Resilience

Module 1.2: Science, Technology, and Innovation

Contents

Learning Outcomes

At the conclusion of this Session, Participants will be able to:

- Ability to define science and technology, and innovation, and to understand what qualifies a system or solution as being “emerging” or “disruptive”
- Increased understanding of the ways science and technology may be used to support society and governance, including the pursuit of sustainable development goals
- Knowledge of the technological solutions available to support digital government and public service innovation for DRR
- Possess the capacity to promote or support the creation and/or advancement of a national science and technology strategy.

1. Introduction

- **Science and Technology (S&T)**
  - Science and technology drive development
  - Long history of S&T milestones
    - Stone age
    - Bronze age
    - Iron age
    - Agricultural revolutions
    - Industrial revolutions
  - Advancements grow in aggregate

Image: Islamic Science and Technology. Museum of the History of Science and Technology in Islam. Istanbul.
Image credit: Nikos Niotis, 2013.

Impact of Science on Society

*"**Science** and **technology** have had a major impact on society, and their impact is growing. By drastically changing our means of communication, the way we work, our housing, clothes, and food, our methods of transportation, and, indeed, even the length and quality of life itself, science has generated changes in the moral values and basic philosophies of mankind. Beginning with the plow, science has changed how we live and what we believe."*

*"By making life easier, science has given man the chance to pursue societal concerns such as ethics, aesthetics, education, and justice; to create cultures; and to **improve human conditions**."*

- Donald P. Hearth, NASA Langley Research Center

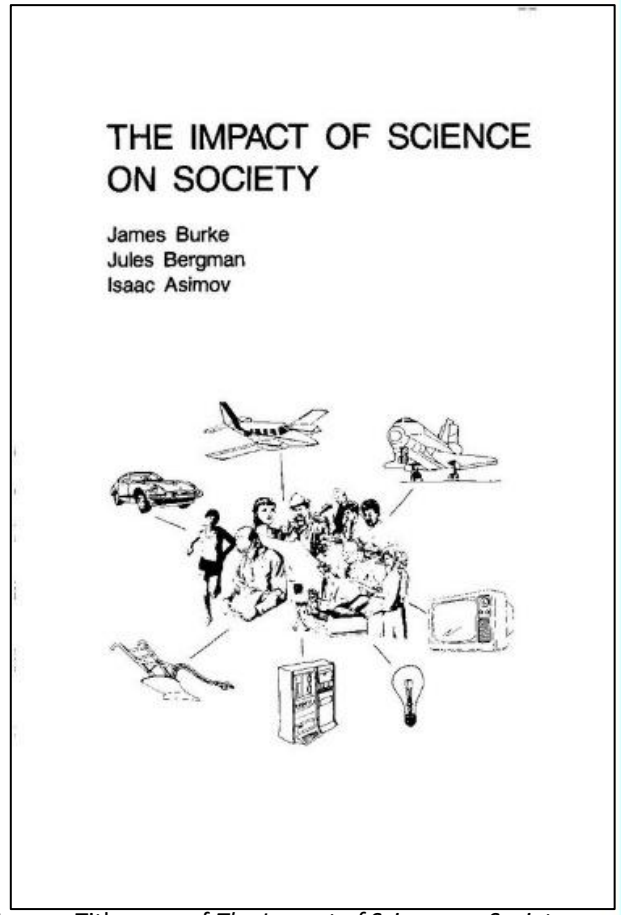


Image: Title page of *The Impact of Science on Society*.
Image credit: Burke, Bergman, and Asimov, 1985.

Disasters and Development

"People around the world are affected by shocks all the time: from economic crises to health emergencies, from social conflicts and wars to disasters caused by natural hazards."

- UN Economic Council, 2019

Image: Hurricane Dorian devastated Abaco Island in the Bahamas in September of 2019.
Image credit: Mark Garten, UNOCHA. September 14. http://bit.ly/2IRZI2Q.

2. Science, Technology, and Innovation (STI)

Science

"[T]he pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence."

- Science Council, 2019

Scientific branches:

- Natural Sciences
- Social Sciences
- Formal Sciences

Image: Scientific research facility.
Image credit: Michael Pereckas, 2008.

2. Science, Technology, and Innovation (STI)

Technology

- Systematic treatment of an art, craft, or technique
- Are based on science
- Emphasis: finding practical ways to apply scientific knowledge to do things more effectively or efficiently
- Balance of benefits and risks

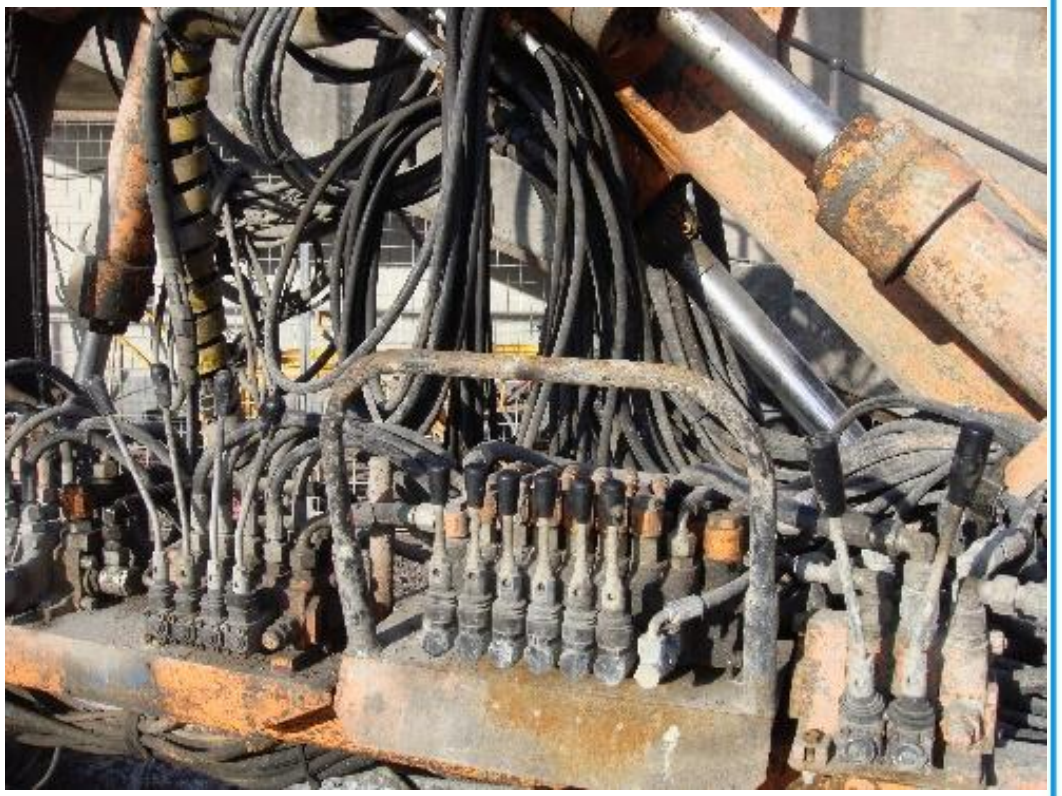
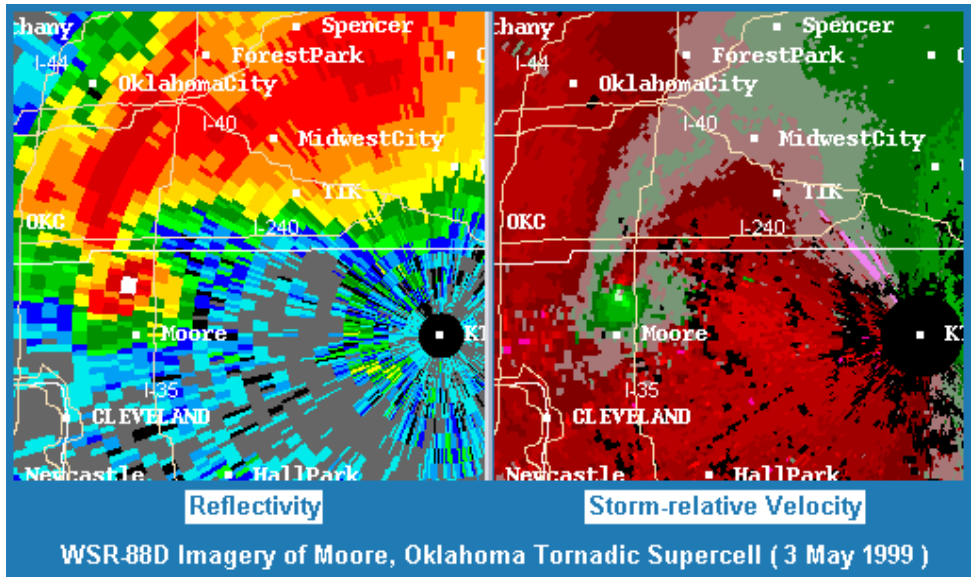


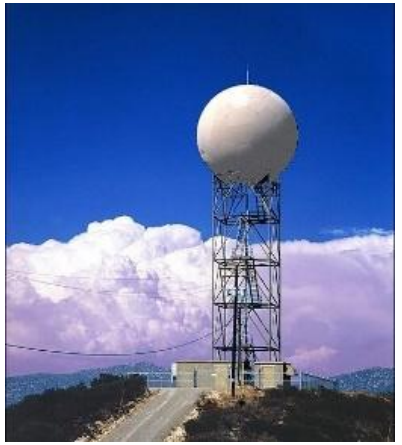
Image: Example of an application of technology in the construction sector.
Image credit: Olle Svensson, 2009.

2. Science, Technology, and Innovation (STI)

Science and Technology Relationship

- Science and Technology support each other
  - Scientific discovery spurs the creation of technological solutions
  - New technologies allow scientists to expand the scope of their discovery
- Every technology based on at least one scientific law or principle





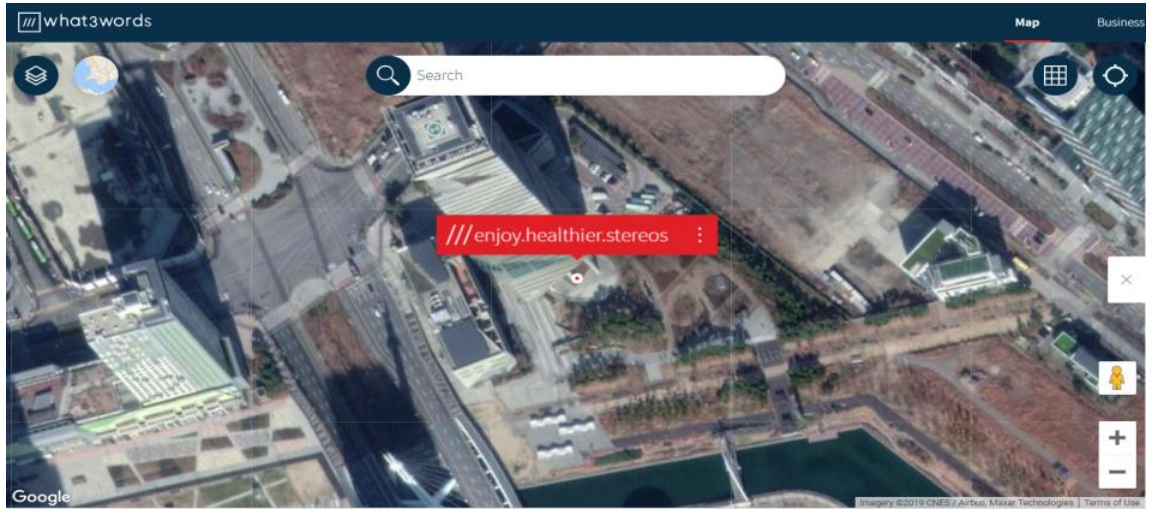
Above Image: Radar-generated imagery of a tornado-producing storm
Right Image: Doppler Radar
Image credit: US Storm Prediction Center, n/d.

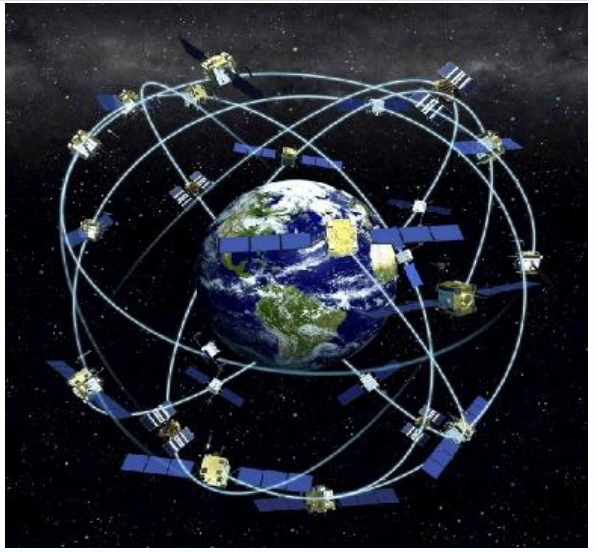
2. Science, Technology, and Innovation (STI)

Innovation

- From Latin: *renew or restore*
- Finding ways to do things better or more effectively

- **Innovation Case Study:** www.what3words.com





Above Image: Screenshot of what3words website
Image credit: what3words.com, 2019
Right Image: Artist's rendering of global positioning satellites orbiting Earth
Image credit: NASA, 2019.

3. STI in Society and Governance

- *"**Science** must respond to societal needs and global challenges."*
- *"**Governments** need to make decisions based on quality scientific information."*
- *"To face sustainable development challenges, governments and citizens alike must understand the language of science and must become scientifically literate."*

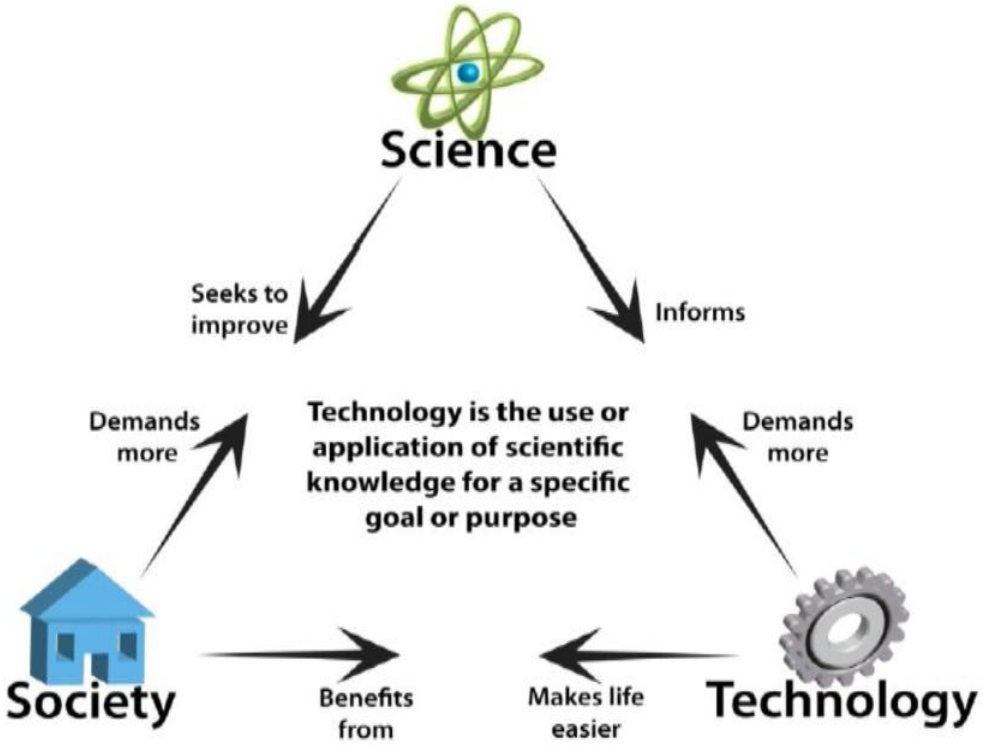


Image: The relationship between science, technology, and society.
Image source: Okafor and Okonkwo, 2015.

3. STI in Society and Governance

STI for Sustainable Development

Video: Science, Technology, and Innovation for Sustainable Development
Video Author: UN DESA, 2016

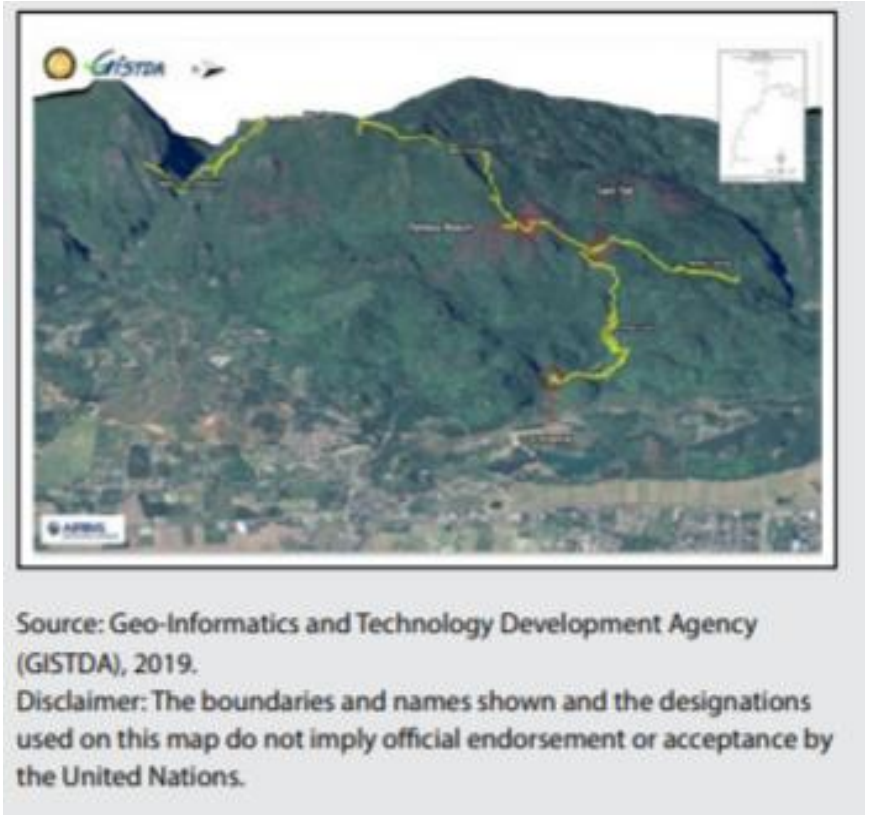
STI for Disaster Risk Reduction

***STI** plays a critical role in ensuring DRR and building resilience*

The use of technology in Thailand cave rescue: Life-saving operation in a challenging terrain

- In **June/July 2018,** 12 boys went on a field trip, in Thailand's Chiang Rai province, with their football coach.
- They **became trapped deep inside a cave** underneath a mountain. The prevailing stormy weather conditions meant that flooding was imminent.
- The **rescue was supported by 3D high-resolution satellite images**, which provided better visualization and understanding of the risk scenarios, evaluation differences, and topographic features of the area.

3D-Satellite Image Map of Tham Luang, Khun Nam Nang, Non-Forest Park, Chiang Rai, Thailand



Source: Geo-Informatics and Technology Development Agency (GISTDA), 2019.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

https://www.unescap.org/sites/default/files/APDR%202019%20Chapter%204.pdf

3. STI in Society and Governance

Global Competitiveness

- World Economic Forum "**Global Competitiveness Index (GCI)"**
- Competitiveness contributes to higher living standards, meeting society's goals

Image: Global Competitiveness Index (GCI) Ratings 2018.
Image source: World Economic Forum, 2019.

3. STI in Society and Governance

- **GCI "Pillars of Competitiveness"**

1. Institutions
2. Infrastructure
3. ICT Adoption
4. Macroeconomic Stability
5. Health
6. Skills
7. Product Market
8. Labour Market
9. Financial System
10. Market Size
11. Business Dynamism
12. Innovation Capability

Image: Global Competitiveness Index "Pillars".
Image source: World Economic Forum, 2019.

Context of STI Adoption

- **Vision, goals, and objectives**
- In the past: scientific methods tended to emphasize the study of individual natural processes rather than systems, analysis more than synthesis, and understanding nature more than predicting its behavior.
- Science focused on short-term, small-scale problems rather than on long-term, large-scale or integrate problems.

- *"Many of the problems now facing humankind can be solved only if we approach science more holistically."*

  - Canada Council, 1999

Image: Wind farm.
Image source: Daxis, 2017.

3. STI in Society and Governance

S&T Acceptability Filters

- **Economics Filter**: The technology must be cost effective or otherwise economically feasible.
- **Ethics Filter**: The technology and its effects on individuals' health, lives, livelihoods, civil and human rights, and other factors, must conform to prevailing ethical standards.
- **Regulatory / Policy Filter**: The technology must conform to safety standards, legal regulations, and policies that pertain to both their application and their intended and secondary impacts.
- **Market Forces Filter**: There must be a recognized and actionable need for the technology that end users respond to by purchasing or otherwise utilizing it.

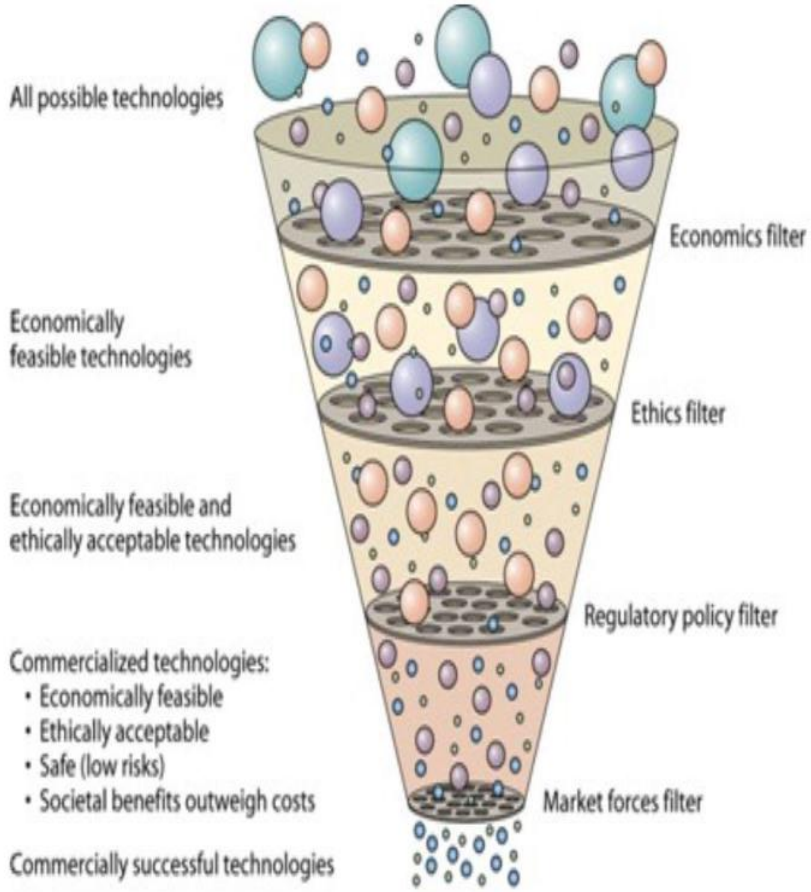


Image: Technology Filters.
Image source: Patrick, n/d.

Information and Communications Technology

- **ICT** is one of the STIs; it does not mean STI as a whole
- **ICT** is the area of technology represented by the convergence:
  - Audio and visual telecommunications systems (cellular, internet, radio, landline, and others), and
  - Computers
- *"Digital channels of computer-mediated communication which include internet websites, government portals, bulletin boards, online discussion forums, cellular communications (texting), social media sites and e-mail."*

  - DiGIT4SD Toolkit, 2019
- *"A diverse set of technological tools and resources used to transmit, store, create, share or exchange information."*

  - UNESCO, 2019

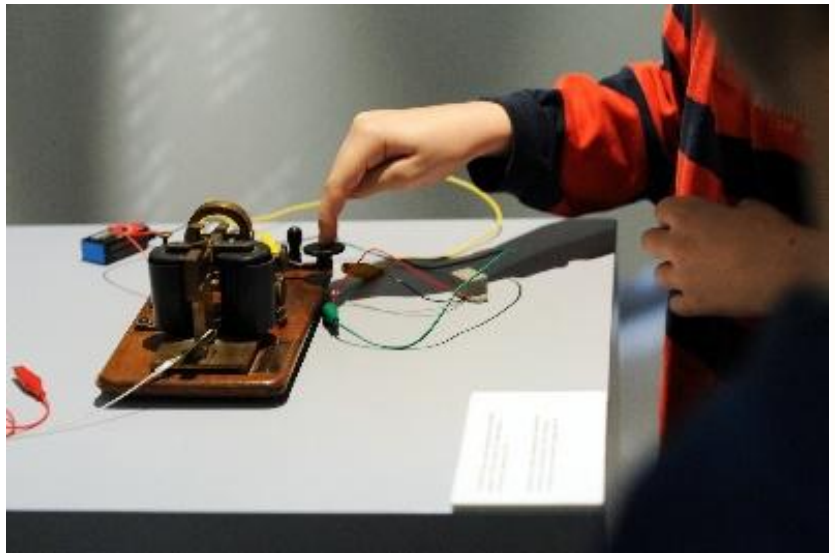
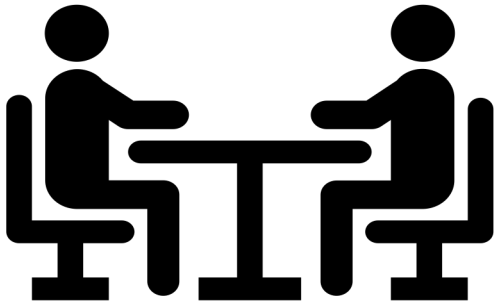


Image: Information and Communications Technology.
Image credit: ITU, 2012.

Group Work and Activities



Group Work and Activities

Discussion 1: Changing Technologies

Technology emphasizes finding practical ways to apply scientific knowledge to do things more effectively or efficiently.

- How has the use of technology changed in your profession over the course of your career?
- Consider the benefits that have been gained because new technologies have been utilized, and the costs that have been incurred.
- Consider benefits and costs relative to the objective being served by the technology, and benefits and costs to society in general.
- Discuss how the technologies you have identified relate to the four filters described. Consider whether there are technologies that are or might be more useful, but that might not meet the requirements of one or more filters?
- Is it ever worthwhile to negate one or more of these filters to ensure a technology is developed? Why or why not?

Group Work and Activities

Discussion 2: ICTs

- Why are ICTs so critical in modern governance and society?
- Consider that:
  - More than half of the world's population is now online.
  - Mobile access to basic telecommunication services is becoming ever more predominant.
  - Broadband access continues to demonstrate sustained growth.
  - Almost the whole world population now lives within range of a mobile-cellular network signal.
  - Internet access at home is gaining traction.

3. STI in Society and Governance

ICT Discussion

- More than half of the world's population is now online
- Mobile access to basic telecommunication services is becoming ever more predominant
- Broadband access continues to demonstrate sustained growth
- Almost the whole world population now lives within range of a mobile-cellular network signal
- Internet access at home is gaining traction

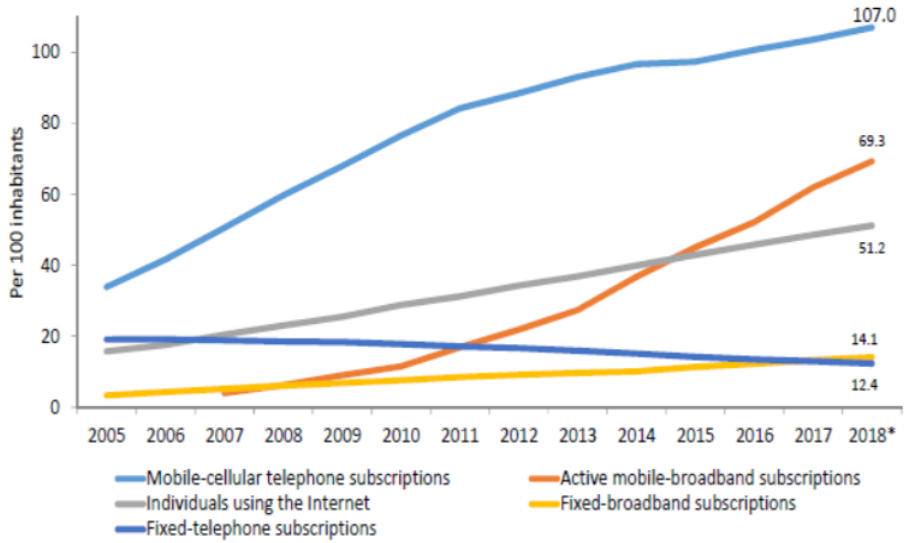


Image: Number of communications subscriptions / accounts per 100 inhabitants, 2005-2018.
Image credit: ITU, 2018.

3. STI in Society and Governance

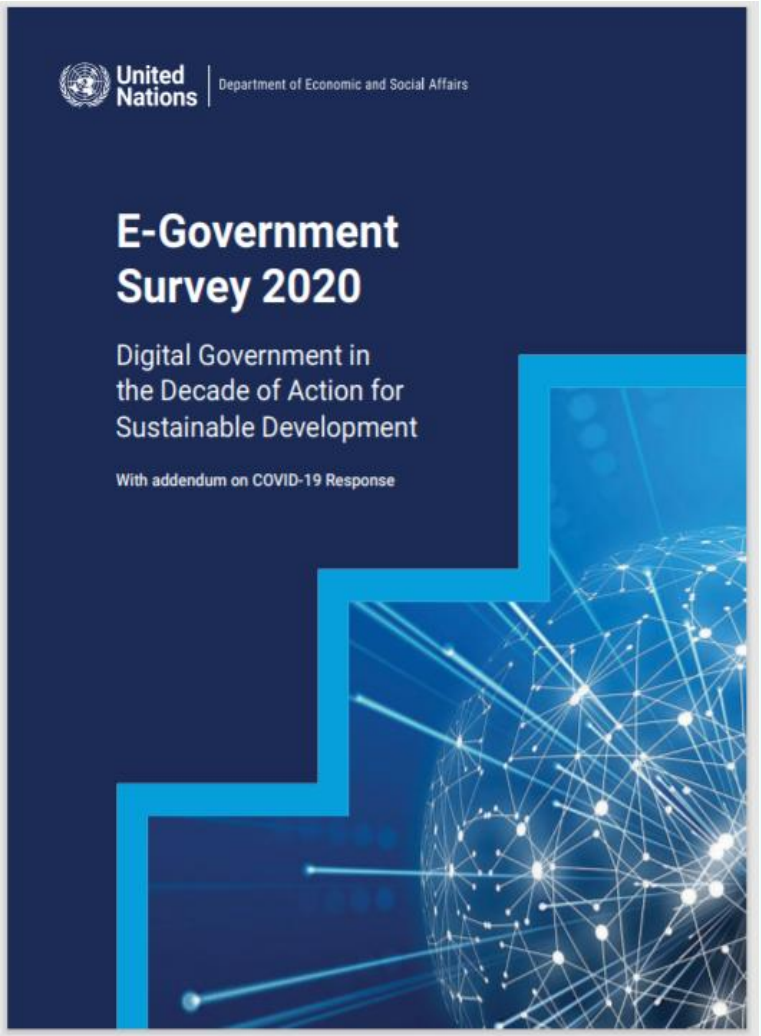
E-Government

- *"**e-government**" and "**digital government**" are used interchangeably, as there is still no formal distinction made between the terms among academics, policymakers and practitioners.*

  - UN E-Government Survey, 2020

- ***Digital government** is not an end; it is a means to improving public service delivery, increasing people's engagement, enhancing transparency, accountability and inclusion, and ultimately making life better for all.*

  - UN E-Government Survey, 2020



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- *"**E-government** can thus be defined as the use of ICTs to more effectively and efficiently deliver government services to citizens and businesses. It is the application of ICT in government operations, achieving public ends by digital means."*

  - UN E-Government Survey, 2018

- **E-Governance:** a component of e-Government in that it refers to the use of ICT for the provision of government services, information dissemination, and communications with the general public.
- e-Administration
- e-Government Services
- e-Democracy

E-Government

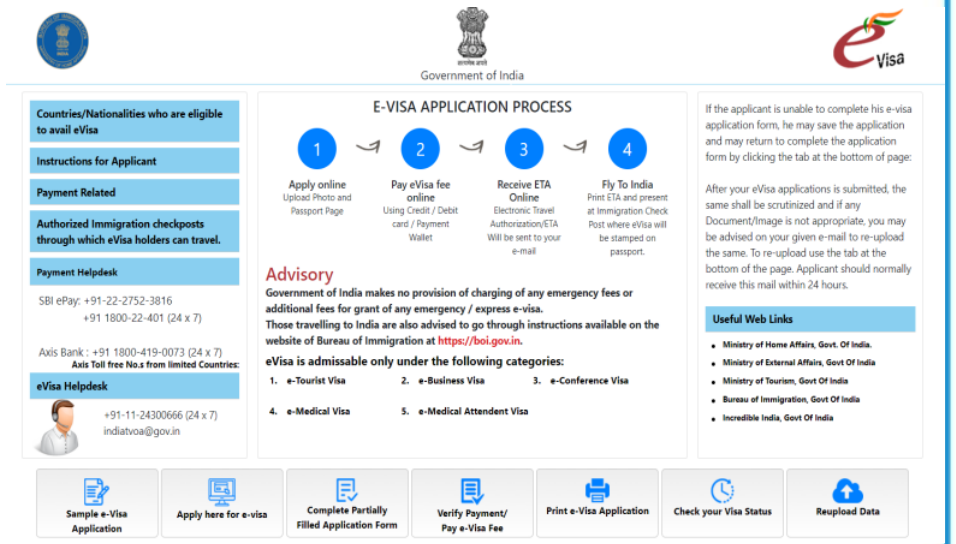

Image: Government of India 'e-Visa' page, 2019.
Image credit: Government of India, 2019.

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Capacities for Digital Transformation

- Digital government transformation is **fundamentally about governance transformation** and **cultural change**
- Digital government transformation **requires a holistic approach that is value-driven and institutionalized across all levels** of government and society
- Digital government transformation should **aim at promoting digital inclusion and ensuring that all people, including vulnerable groups**, can access new technologies to improve their wellbeing

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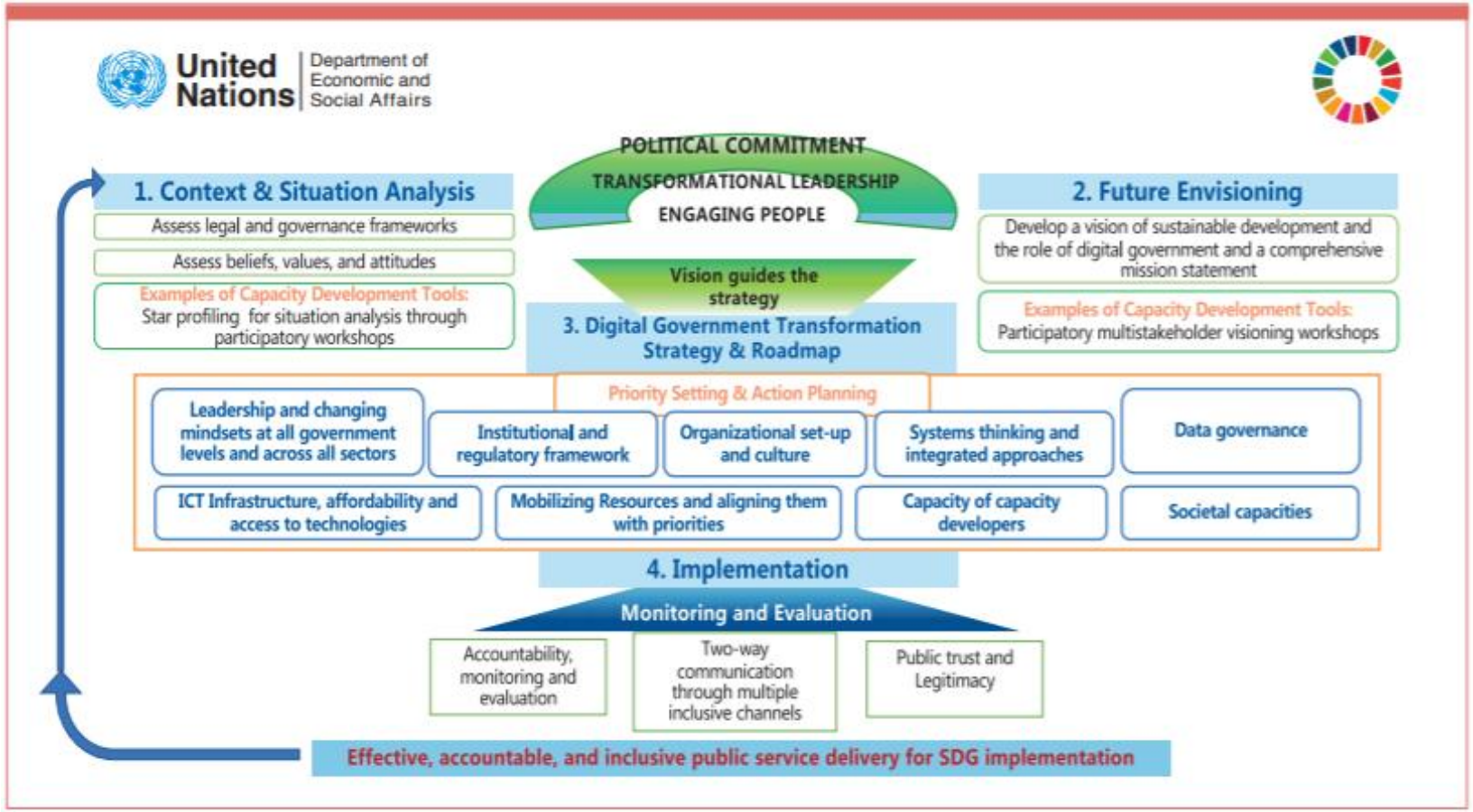
- **A holistic approach to digital government transformation and capacity development**



https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2020-Survey/2020%20UN%20E-Government%20Survey%20(Full%20Report).pdf

3. STI in Society and Governance

- **4 'Pillars' of E-Government**

  - People
  - Process
  - Technology
  - Resources

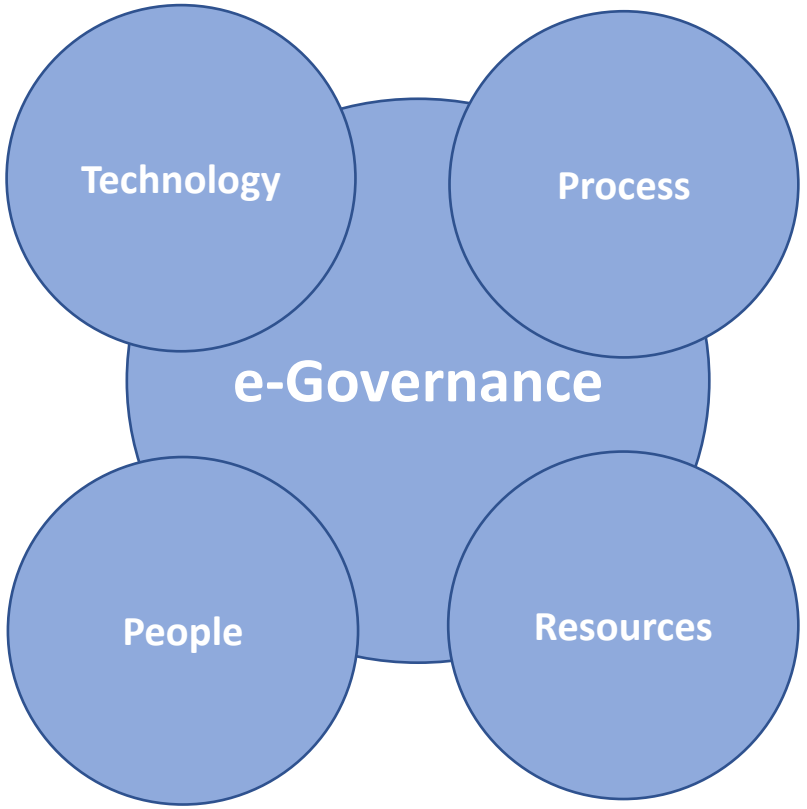


Image: Four components of e-Government

E-Gov and the SDGs

- **E-Government** / **E-Governance** powerful tool in meeting SDGs
- ICTs increase reach, transparency, cost, and effectiveness

- *"**e-Government** is not about 'e' but about 'government'; it is not about computers and websites, but about services to citizens and business. e-Government is also not about translating processes; it is about transforming them.*

  - Mohanty, 2016

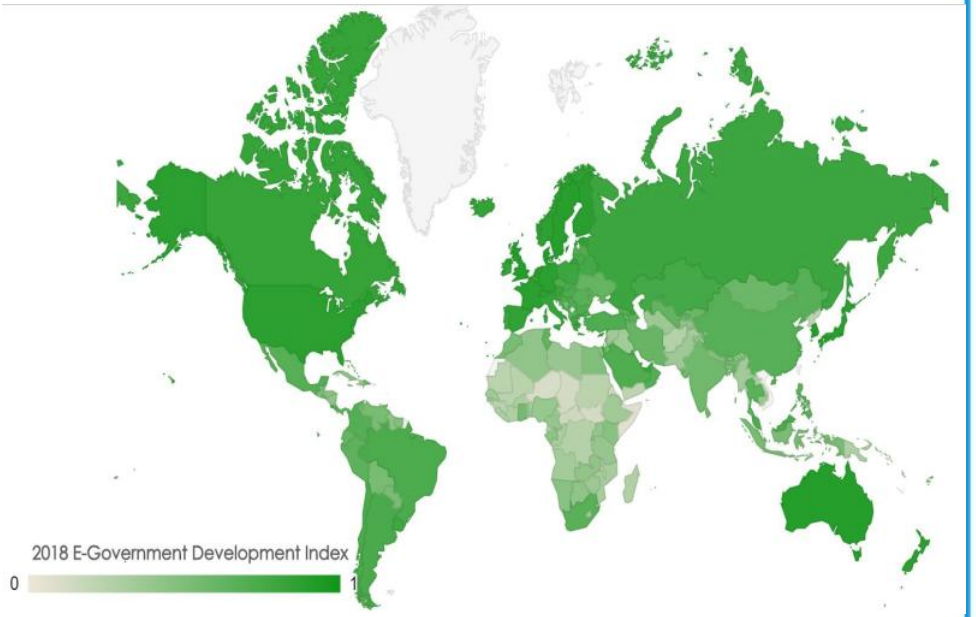


Image: e-Government Development Index
Image credit: UN e-Government knowledgebase, 2018

E-Government Implementation Considerations

- Political Conditions
- Organizational Conditions
- Cultural Context & Human Capita
- Financial Conditions
- Communications Environment
- Technological Infrastructure
- Data & Information Systems

Image: DiGIT4SD e-Government Implementation Process
Image credit: UNDESA, 2019

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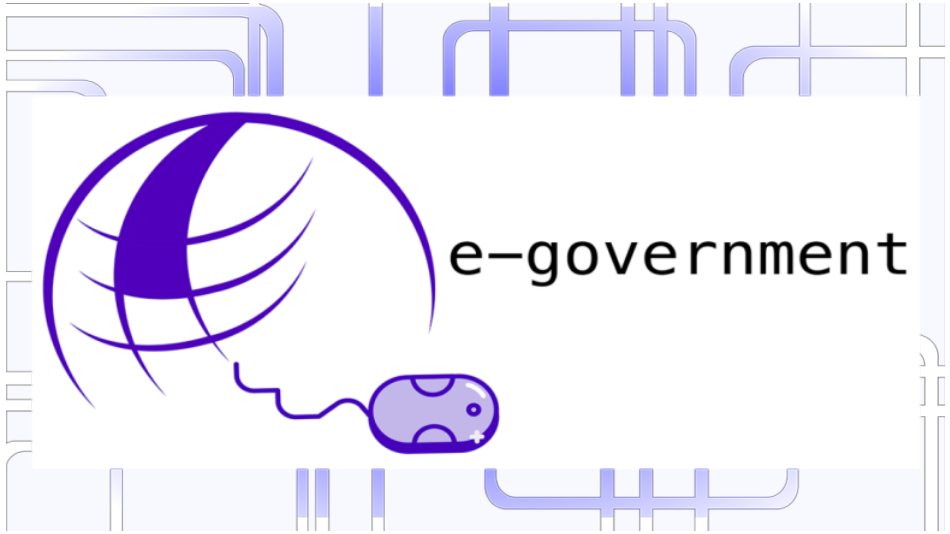
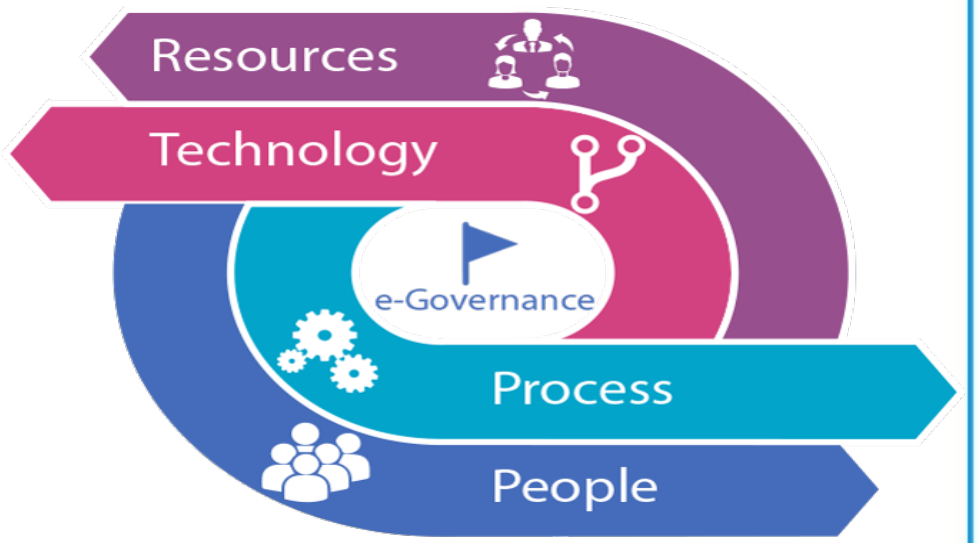
E-Government as a Sustainable Development Platform

E-Government and ICT are recognized as great enablers for achieving the 2030 Agenda

- **Disasters constrain government efforts in achieving the 2030 Agenda.**
- **Disasters forestall new opportunities for growth and prosperity**
- **E-resilience and sustainable development are highly interrelated.**



https://www.syneidis.com/e-government-relationship-citizens/



http://paya-net.ir/products/software/egovernment/

E-Government and Sustainable Development

E-Government services help integrate and strengthen the three pillars of sustainable development

- Economic
- Social and
- Environmental

Social Sustainability	Environmental Sustainability	Economic Sustainability
• E-government services for public health ("e-health") • E-government services for the poor and disadvantaged groups, including particularly, in rural areas (e.g., e-information services for agriculture) • E-employment services	• E-environmental monitoring services • New e-government services based on combined environmental data and products such as maps and statistical analysis	• E-procurement services for greater efficiency and provision of information and other e-government services to business • E-payment services to (rural) poor

The Role of E-Government for DRR

- E-Government and ICTs role across the phases of DRR and management is highly recognized
  - Mobile channel/devices are key to building DRR esp. in developing countries
  - Social media is also critical for building e-resilience and DRR.

- E-resilience and the use of ICTs in DRM are key e-government initiatives
- E-resilience has the potential to reduce
  - disaster risks and improve disaster management
  - economic loss and preventing human casualties.
- Mainstreaming e-resilience in all phases of DRR requires concerted efforts

https://www.quora.com/Which-is-the-first-phase-in-the-disaster-management-cycle

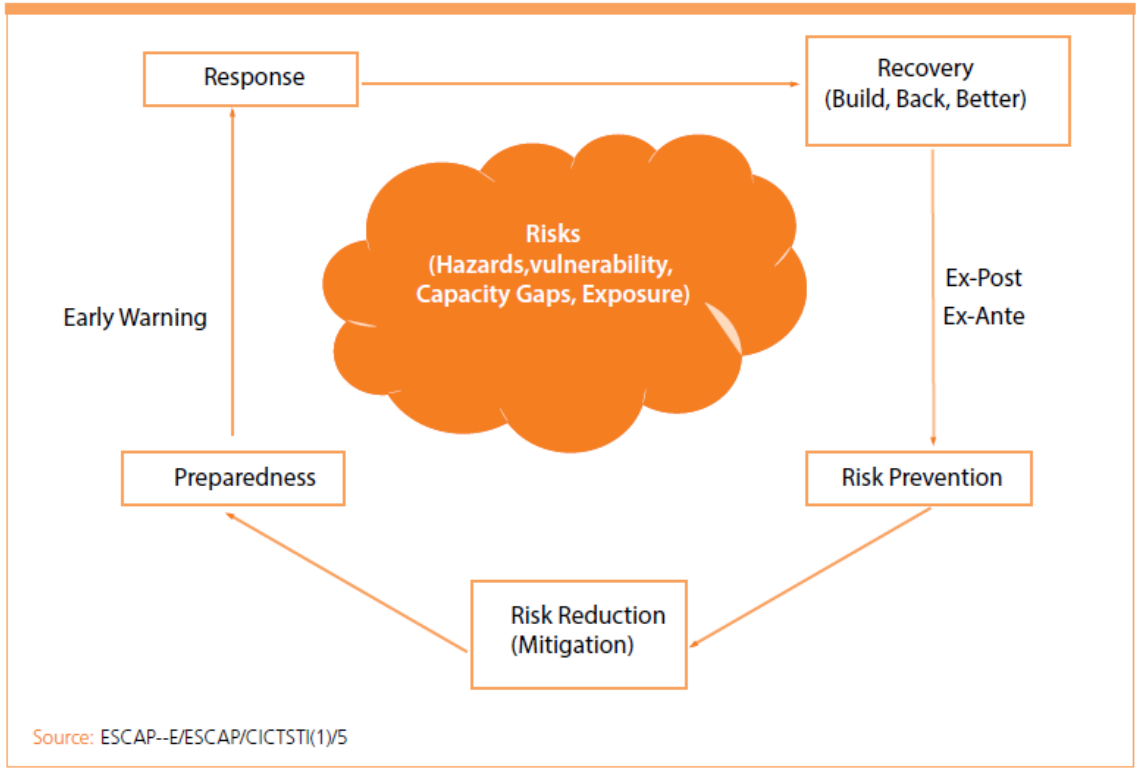
The Role of E-Government for DRR

E-Government plays a critical role in the pre-disaster and post-disaster management phases. E-Government improves disaster -

- Mitigation and Prevention
- Preparedness
- Response
- Recovery

E-Government and ICT services helps build resilient societies

Disaster Management Cycle



Source: ESCAP--E/ESCAP/CICTSTI(1)/5

Source: https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2018-Survey/E-Government%20Survey%202018_FINAL%20for%20web.pdf

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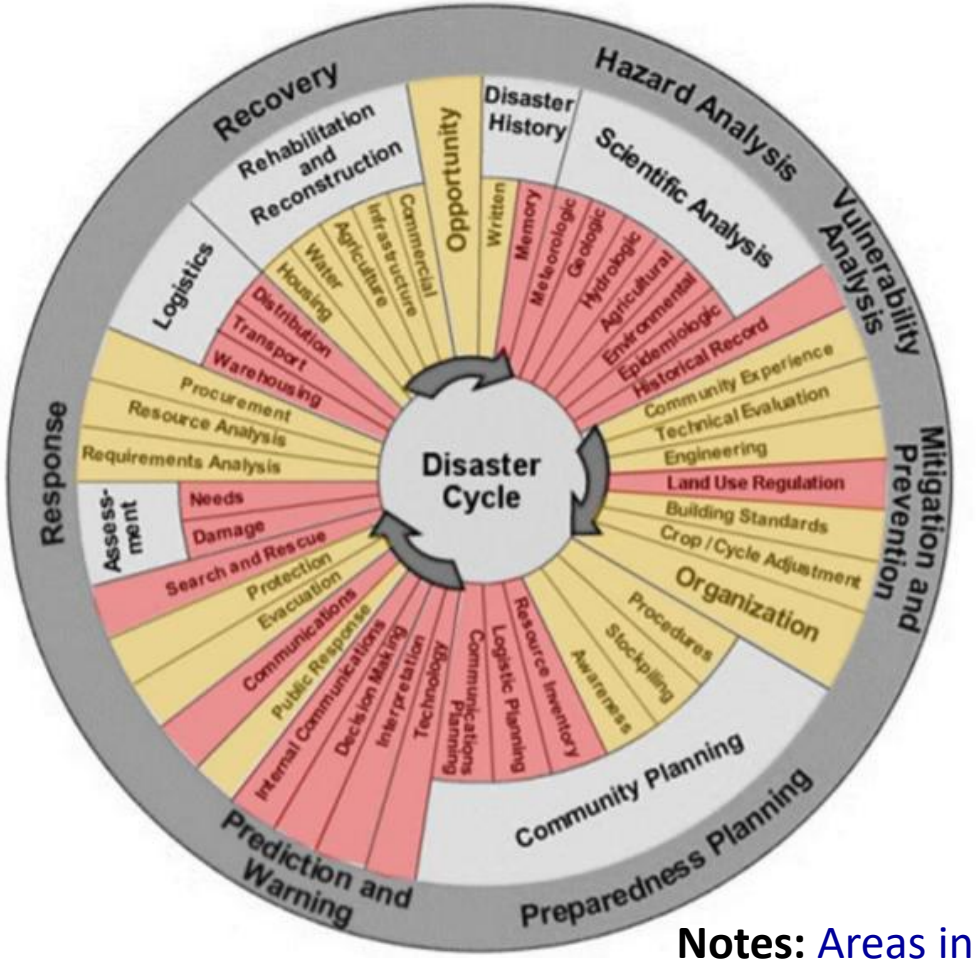
- **DRM cycle and the importance of ICTs in various activities and phases**



Notes: Areas in red indicate ICTs playing a main role; and areas in orange indicate ICTs playing a lesser role.

https://www.unapcict.org/sites/default/files/2020-08/Academy%20Module%20on%20ICT%20for%20DRM.pdf

E-resilience and its Linkages to ICT and E-Government

E-resilience:

- is ICT contributions to resilience, particularly at the community level.
- the use of ICTs during all phases of DRM
  - prevention, reduction, preparedness, response and recovery
  - towards reducing risk and impact and maintaining the gains on sustainable development, including through e-government.

E-resilience entails **two main dimensions:**

- ICTs for disaster risk prevention, risk reduction and preparedness
- disaster response and recovery, rapid restoration of ICT infrastructure and services.

E-resilience and Role of ICT in DRM

DRM Phases / ICT Roles	Prevention	Reduction	Preparedness	Response	Recovery
Key Tasks	Improving risk information as basis for investments and business strategies / operations	Reducing the chance of disasters and mitigating the level of disruptions, damage & losses	Planning and getting adequately and appropriately ready to respond to any disaster eventuality, in a timely manner	Saving lives, preventing further damage and losses and meeting immediate needs during disasters	Being able to restore functions, recover assets and operations, and build back better
ICT for its own resilience (ICT Sector)	• Not to create/ increase risks • Not to exacerbate existing risks • Avoid and transfer risks	• Address the underlying factors of risks • Reduce vulnerability • Increase capacity/ protection • Undertake retrofitting • Reduce exposure • Invest in early warning	• Plan System/network continuity • Implement system redundancy/backup • Ensure response readiness • Conduct training and drills • Set up emergency response and communication mechanisms	• Gather data and information on any damage and disruptions to the ICT infrastructure, facilities and services • Restore and repair services, data, facilities and equipment • Activate emergency communication systems, such as satellite systems and mobile communication units	• Conduct rapid assessment of damage and losses • Assess needs for recovery • Factor in additional investment to reduce future risks
ICT for society's resilience (non-ICT Sectors)	• Make ICTs available to improve risk assessments • ICT as crucial instruments for analysis • ICT to enhance development/ business investment planning	• Set up risk databases • Introduce Geo-Referenced Information Systems (GIS) for decision making, planning and mitigation • Expand ICT as a tool for disaster knowledge, innovation, education • Enhance coordination via ICT • Enhance risk observation, assessment and early warning by ICT	• Plan and put in place emergency decision making tools (assessment, mapping, databases, planning) with ICT • Set up and enhance emergency/humanitarian communication, application and coordination • Position ICT as one of comon services to all sectors	• Gather data and information on casualties, losses and damage for coordinated responses • Request for satellite imagery of affected areas • Activate data backup in case socioeconomic data is lost. • Inform citizens of available emergency services and information via SMS, website, radio or PA	• Enhance rapid assessments and detailed Post Disaster Needs Assessment (PDNA) • Use ICT systems and applications to facilitate disaster response efforts • Inform more robust future investment within the recovery framework

Source: ESCAP--E/ESCAP/CICTSTI(1)/5

Global Initiatives of DRM and ICT

- Global Partnership for Preparedness
  (Source: https://www.agendaforhumanity.org/initiatives/3840)
- **One Billion Coalition for Resilience (1BC)**
  (Source: http://media.ifrc.org/1bc/)
- **Insurance Development Forum (IDF)**
- **Platform on Disaster Displacement**
  (Source: https://www.agendaforhumanity.org/initiatives/3833)
- **Inform (Index for Risk Management)**
  (Source: http://www.inform-index.org/InDepth)

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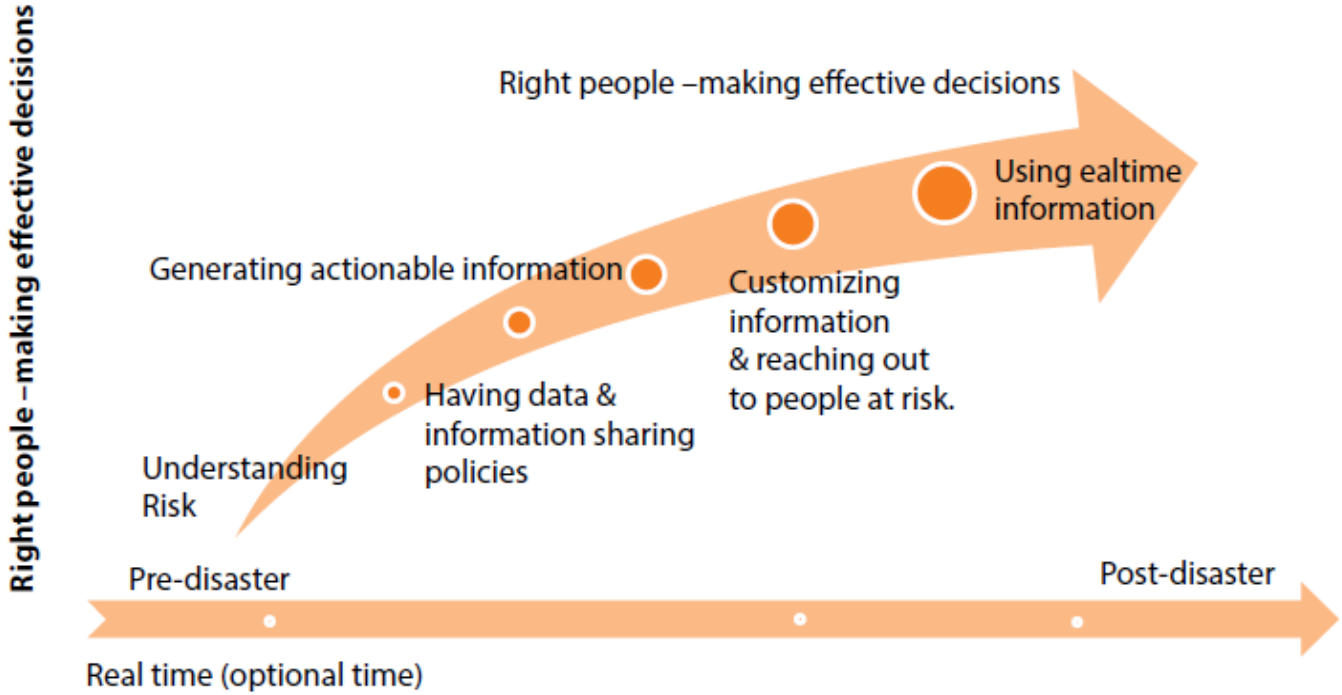
- **E-resilience Guiding Principles**



Source: ESCAP--E/ESCAP/CICTSTI(1)/5

- **Key Recommendations**

  - Systematic and sustained efforts towards e-resilience
  - Awareness raising, participation and capacity development
  - Sharing of good practices and lessons learned

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- ## E-Government in Estonia

Video: The Future of Work – Jobs and Automation in Estonia
Video Author: HBO, 2019

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E-Government/Digital Government Case Study

- Mauritius is an ICT leader in Africa
- Vision: *A highly inter-connected society with access to the knowledge required for an Innovation-driven culture.*
- Digital government dependent on Open Data – *Open Data Mauritius*

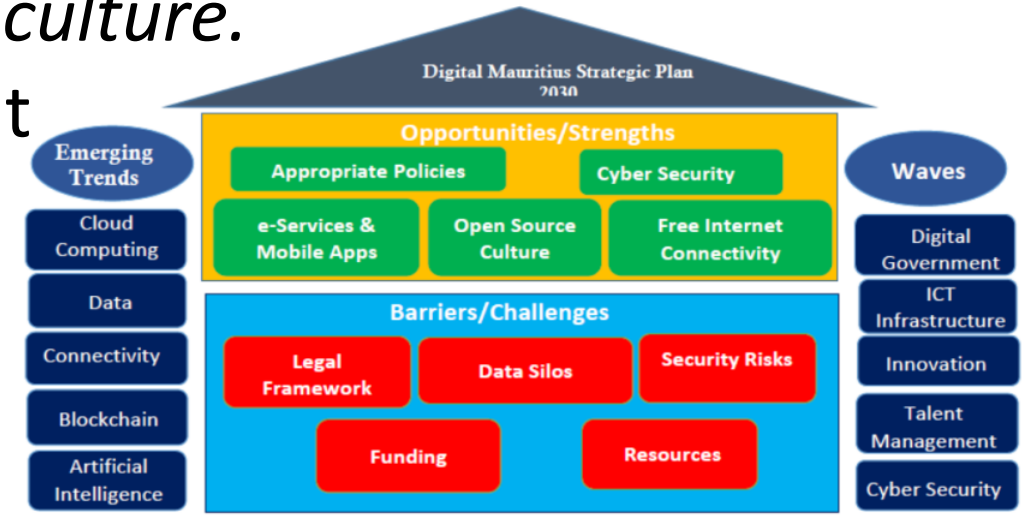


Image: Digital Mauritius Strategic Plan Framework
Image credit: Government of Mauritius, 2019

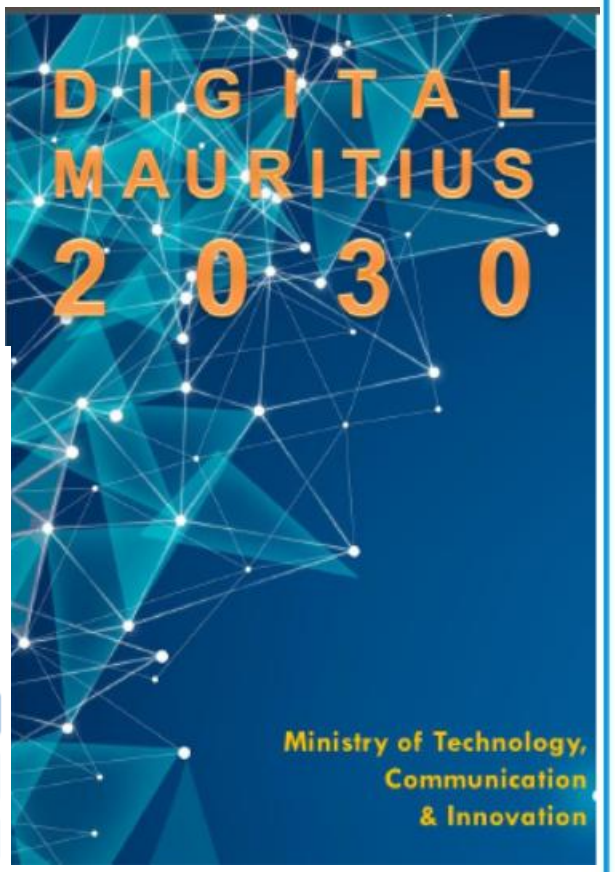


Image: Digital Mauritius 2030 strategic plan cover
Image credit: Government of Mauritius, 2019

3. STI in Society and Governance

Smart Cities

- An urban area that improves service reach, effectiveness, and efficiency through the use of web-based devices that collect data and manage assets and resources
- Significant investment in infrastructure, training, and maintenance
- Must be economically, culturally, socially, and geographically appropriate

- **Three factors**:
  - Technology
  - Human
  - Institutional

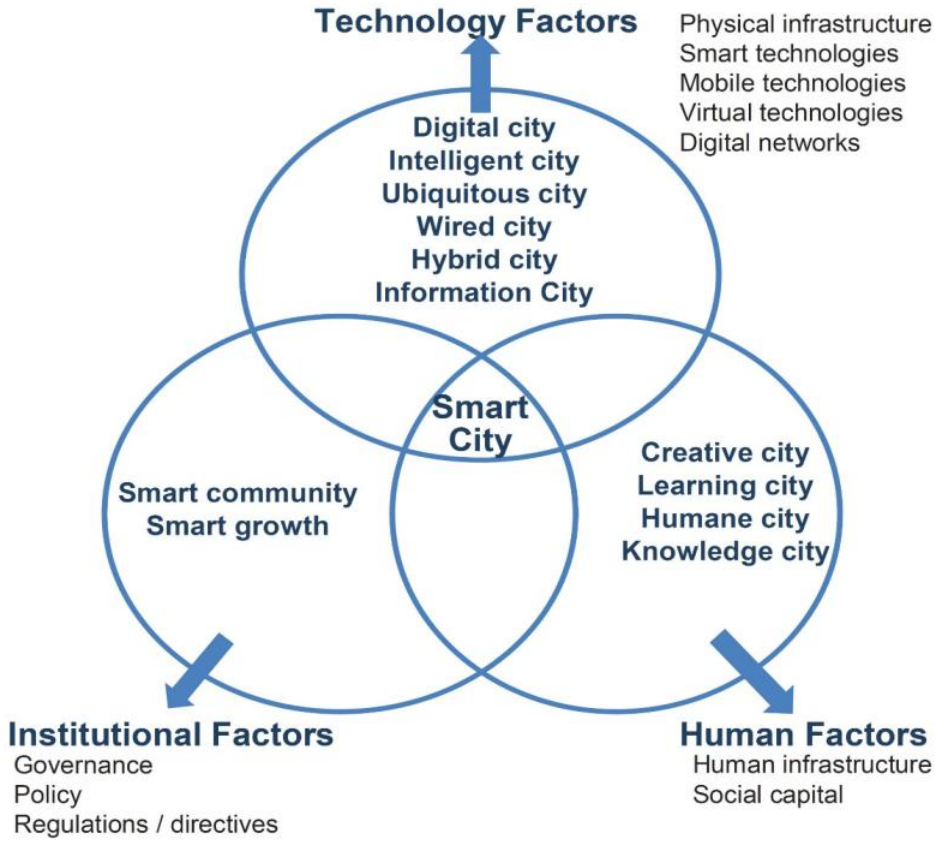
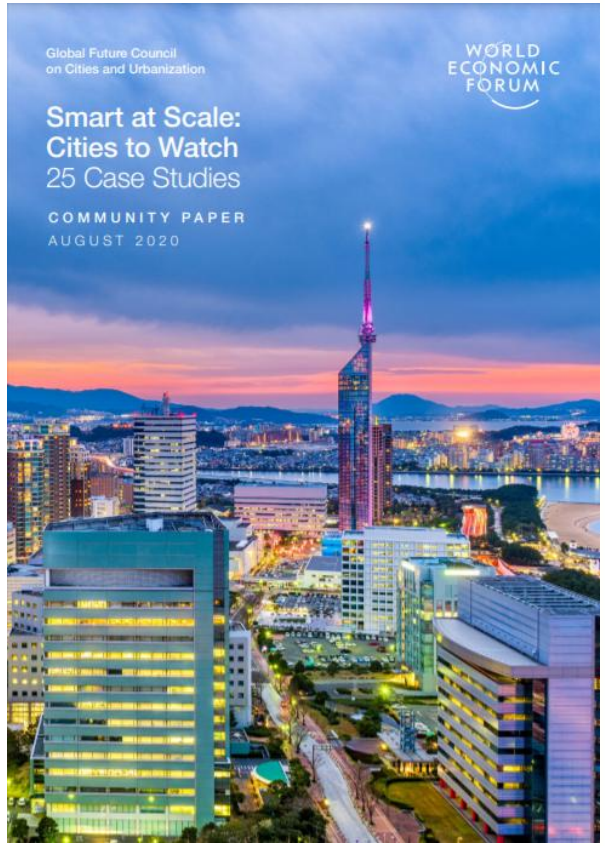


Image: Fundamental components of a Smart City
Image credit: Taewoo and Pardo, 2011

Smart Cities and E-Government

- Smart cities initiatives are emerging globally
- By 2050, more than two thirds of the world's population are expected to live in cities
- Cities are taking advantage of advancements in E-Government to become smarter
- Smart cities are characterized by conscious efforts to use ICTs
- E-Government emerges as a fundamental tool in making cities smart

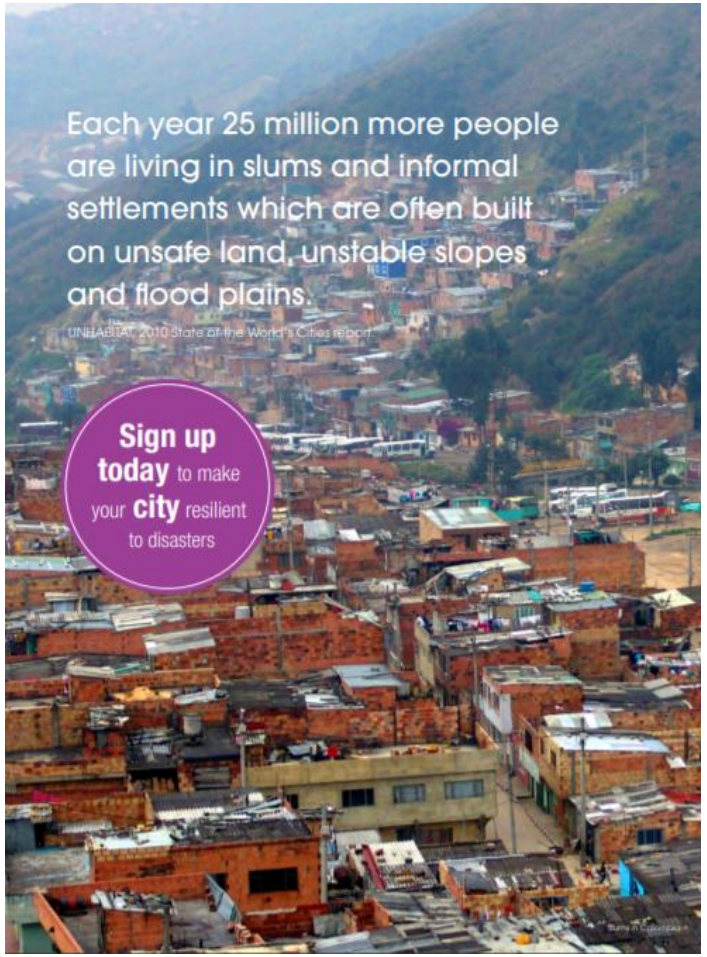


http://www3.weforum.org/docs/WEF_Smart_at_Scale_Cities_to_Watch_25_Case_Studies_2020.pdf

3. STI in Society and Governance

Making Cities Resilient - Drivers of Disaster Risk in Urban Settings

1. Rising urban populations and increased density
2. Weak urban governance
3. Unplanned urban development
4. Lack of available land for low-income citizens
5. Inappropriate construction
6. Concentration of economic assets
7. Ecosystems decline



https://www.preventionweb.net/files/14043_campaignkit1.pdf

3. STI in Society and Governance

Making Cities Resilient - 10 Essentials for Building Urban Resilience

1. Institutional and administrative framework
2. Financing and resources
3. Multi-hazard risk assessment
4. Infrastructure protection, upgrading and resilience
5. Protecting vital facilities of education and health
6. Building regulations and land use planning
7. Training, education and public awareness
8. Environmental protection and strengthening of ecosystems
9. Effective preparedness, early warning and response
10. Recovery and rebuilding communities

"I urge local authorities to accelerate all efforts to make cities safer to prevent the loss of lives and assets".

- Mr. Ban Ki-moon, 8th UN Secretary-General

Ten most populous cities and associated disaster risk

City	Population (million)	Disaster risk					
		Earthquake	Volcano	Storms	Tornado	Flood	Sturm surge
Tokyo	35.2	x		x	x	x	x
Mexico City	19.4	x	x	x			
New York	18.7	x		x			x
São Paulo	18.3			x		x	
Mumbai	18.2	x		x		x	x
Delhi	15.0	x		x		x	
Shanghai	14.5	x		x		x	x
Kolkata	14.3	x		x	x	x	x
Jakarta	13.2	x				x	
Buenos Aires	12.6			x		x	x

https://www.preventionweb.net/files/14043_campaignkit1.pdf

3. STI in Society and Governance

Smart City Case Study – Songdo, Korea

- Planned Smart City
- Construction began in 2008
- RFID, CCTV, and Internet
- Wide range of public and private services, including
  - ✓ Transportation
  - ✓ Safety and Security
  - ✓ Emergency Response
  - ✓ Environment
  - ✓ Energy
  - ✓ Citizen Interaction
  - ✓ Integrated Facility Management
  - ✓ Private Services

Image Above: Songdo, Incheon, Republic of Korea
Image credit: IDB-KRIHS, 2016
Image Right: Services provided by Songdo Smart City (U-City)
Image credit: IDB-KRIHS, 2018

3. STI in Society and Governance

Smart City Case Study – Songdo, Korea

Songdo Emergency and Response Services

- Real-time emergency / disaster information collected
- Hazard monitoring
- Public alert and warning

Image: Diagram of emergency response services provided by Songdo Smart City system.
Image credit: IDB-KRIS, 2016.

Case Study: Open Data Roadmap – Maputo, Mozambique

- The mayor of Maputo launched the **Open Data Roadmap initiative** to improve transparency and accountability.
- Maputo, the capital is relatively small.
- A grid network and several robust urban planning initiatives in the downtown area have laid good foundations for a well-planned city.
- However, nearly 75% of the city's population lives in informal settlements.
- This is a simple use of digital capacity for e-governance and urban planning.

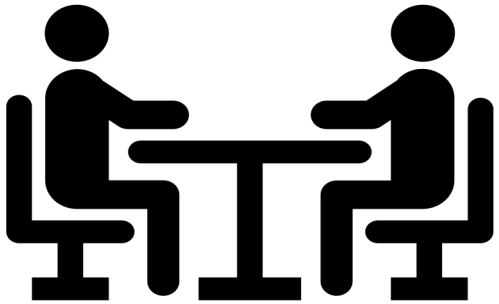
http://www3.weforum.org/docs/WEF_Smart_at_Scale_Cities_to_Watch_25_Case_Studies_2020.pdf

Case Study: Harnessing City Data – Singapore

- Singapore has been harnessing data to enhance services and create economic value.
- By leveraging a combination of government and private-sector data in a citywide data platform.
- This effort supports better decision-making and planning in six pilots, including health.
- **ConnectedLife's** home monitoring solution provides insights to health providers.
- The solution combines smart technology (IoT, such as motion and sound sensors, data analytics and AI)

http://www3.weforum.org/docs/WEF_Smart_at_Scale_Cities_to_Watch_25_Case_Studies_2020.pdf

Group Work and Activities



Discussion 3: Link between E-Government, Smart Cities, and Emerging Technologies Adoption

- Is the existence of or progress towards E-Government or Smart City a requirement for the successful adoption of new technologies for DRR and resilience?
- What is the role of E-Government in promoting Smart Cities and making cities resilient?
- What kinds of changes are occurring in the DRM sector because of technology disruption?

4. New Technologies: Emerging, Disruptive, and Frontier

- **New technologies** broadly refers to emerging technologies that are currently developed or will be developed overtime with the potential to change the way things are currently done, whether as an improvement in efficiency or effectiveness, or to completely disrupt the status quo.

- **Four major periods of transformation**
  - **First** Industrial Revolution
    - Manufacturing processes
  - **Second** Industrial Revolution
    - Technological revolution
  - **Third** Industrial Revolution
    - Electronics / nuclear power
  - **Fourth** (current) Industrial Revolution
    - Shifting role of technology

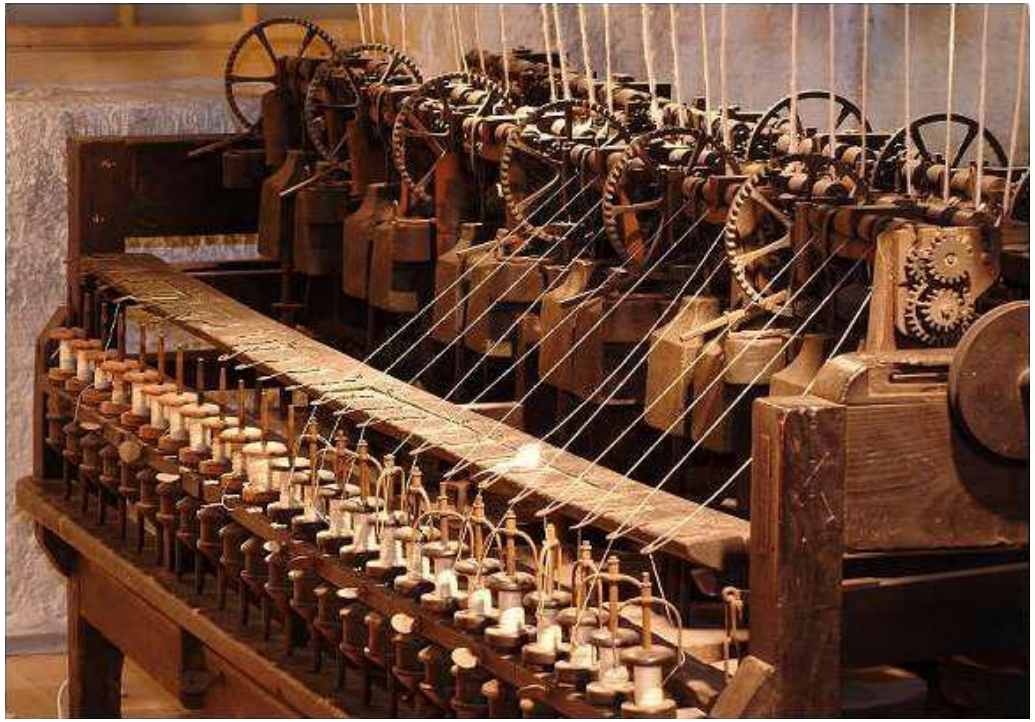


Image: Richard Arkwright's water frame, designed to more efficiently spin thread, was developed in 1769 at the start of the Industrial Revolution. Innovations made to existing technologies in order to increase capacity many-fold revolutionized the textile industry. Image credit: Jason Miller, n/d.

4. New Technologies: Emerging, Disruptive, and Frontier

"Previous industrial revolutions liberated humankind from animal power, made mass production possible and brought digital capabilities to billions of people. This Fourth Industrial Revolution is, however, fundamentally different. It is characterized by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human."

- Klaus Schwab, 2017

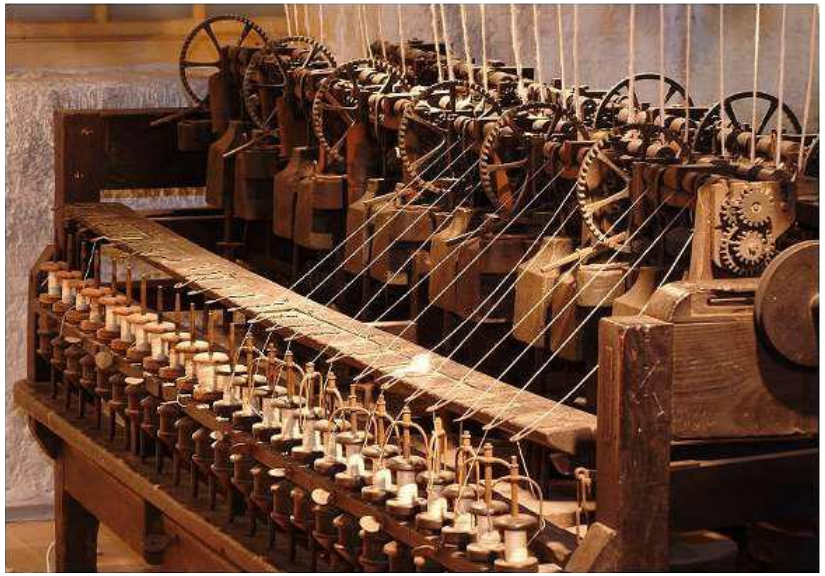


Image: Richard Arkwright's water frame, designed to more efficiently spin thread, was developed in 1769 at the start of the Industrial Revolution. Innovations made to existing technologies in order to increase capacity many-fold revolutionized the textile industry. Image credit: Jason Miller, n/d.

4. New Technologies: Emerging, Disruptive, and Frontier

- **4th Industrial Revolution**

Video: The Fourth Industrial Revolution
Video Author: WEF, 2015

4. New Technologies: Emerging, Disruptive, and Frontier

Emerging and Disruptive Technologies

Emerging Technology:

- Change the way things are done.
- *"New technologies that are currently developing or will be developed over the next five to ten years, and which will substantially alter the business and social environment."*

- Business Dictionary, 2019

Disruptive Technology:

- Change the way things are done.
- Render current technologies obsolete
- Take the place of existing processes

*Existing laws may not be adequate in either case

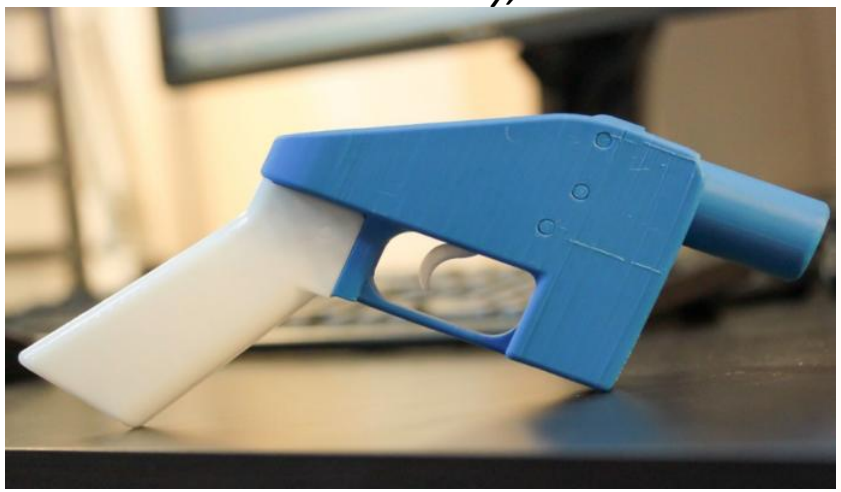


Image: 3-D printed handgun.
Image credit: Colorado Public Radio, 2018.

4. New Technologies: Emerging, Disruptive, and Frontier

Frontier Technology:

- *"Have the potential to disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services"*

  - UNESCAP, 2018

- Many frontier technologies are 'General Purpose Technologies (GPTs)'
  - Pervasiveness
  - Improvement
  - Innovation spawning
- May be new, a different application, or bundling of more established applications

OECD	World Bank	World Economic Forum	McKinsey Global Institute	Institute of Development Studies	MIT Technology Review 2018
Internet of Things	Fifth-generation (5G) mobile phones	Artificial intelligence	Mobile internet	3D printing	3D Metal Printing
Big data analytics	Artificial intelligence	Robotics	Automation of knowledge work	Collaborative economy tools	Artificial Embryos
Artificial intelligence	Robotics	Internet of Things	Internet of Things	Alternative internet delivery	Sensing City
Neuro technologies	Autonomous vehicles	Autonomous vehicles	Cloud technology	Internet of Things	Artificial intelligence for Everybody
Nano/micro satellites	Internet of Things	3D printing	Advanced robotics	Unmanned aerial vehicles/drones	Dueling Neural Networks
Nanomaterials	3D printing	Nanotechnology	Autonomous and near-autonomous vehicles	Airships	Babel-Fish Earbuds
3D printing (additive manufacturing)		Biotechnology	Next-generation genomics	Solar desalination	Zero-Carbon Natural Gas
Advanced energy storage technologies		Materials science	Energy storage	Atmospheric water condensers	Perfect Online Privacy
Synthetic biology		Energy storage	3D printing	Household-scale batteries	Genetic fortune-telling
Blockchain		Quantum computing	Advanced materials	Smog-reducing technologies	Materials' Quantum Leap
			Advanced oil and gas exploration		
			Renewable energy		

Image: Table of frontier technologies as identified by different organizations and institutions.
Image credit: UNESCAP, 2018.

4. New Technologies: Emerging, Disruptive, and Frontier

- **Technology Disruption**

Video: Technology Disruption – Videa Mooneegan
Video Author: TEDxPlainesWilhems, 2016

4. New Technologies: Emerging, Disruptive, and Frontier

Technology Inter-dependencies

- Many ***emerging, disruptive***, and ***frontier technologies*** are at least partially dependent on existing or other new and emerging technology
- Combinations of different emerging technologies may be better able to solve major world problems in ways they individually are not able to

Image: Ways that emerging technologies are helping to protect the ocean environment.
Image credit: WEF, 2016.

5. Data and Information for Risk-informed Decision-Making

Data and Information in Society

- Data generated all the time
  - Click on a digital device
  - Phone call
  - Credit card transaction
  - Vending machine transaction
  - GPS trackers in vehicles
  - Social media
- Digital footprints are left everywhere
- Firms recognizing the value of data, pursuing new ways to capture information generated by activities and contained in places and things
- Enormous value of data
- Data generate additional data through analysis

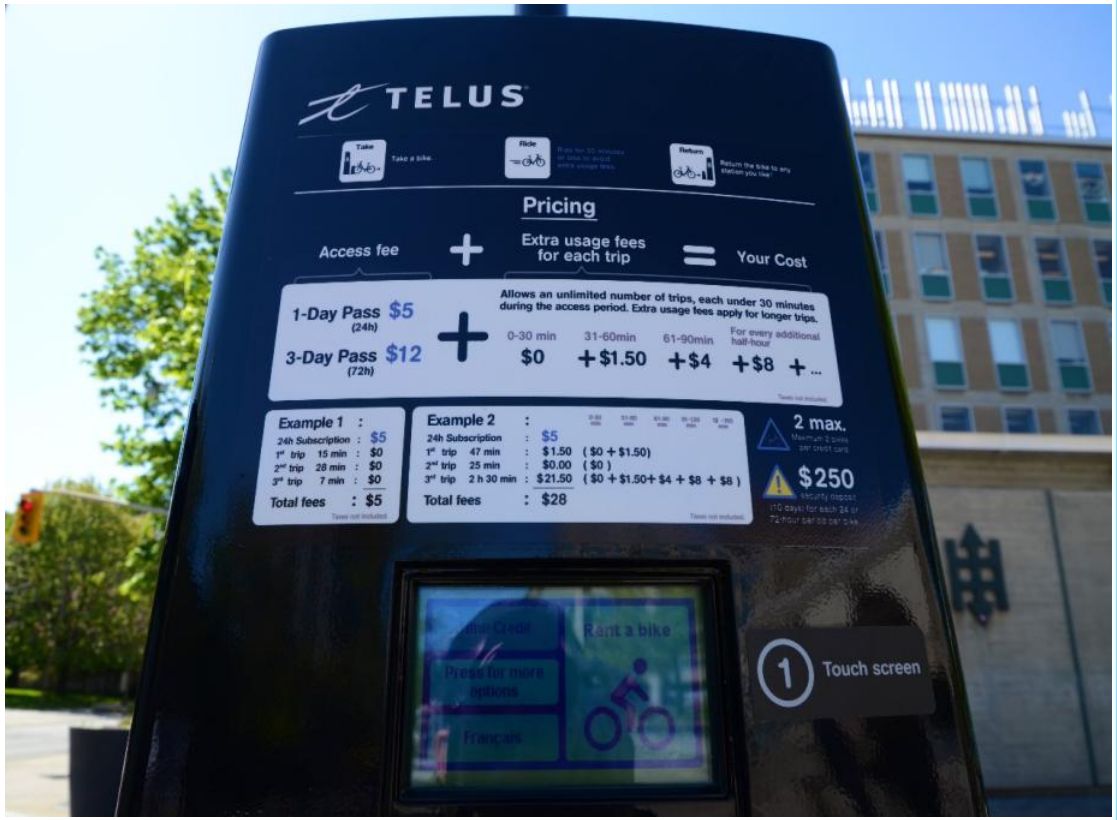


Image: Kiosk for bike rental transactions in Toronto, Ontario.
Image credit: Kevin Zolkiewicz, 2012.

5. Data and Information for Risk-informed Decision-Making

Data and Information Defined

Data

- Unprocessed numbers, figures, facts, or images
- Rarely able to provide a benefit on its own
- Data processed by applying knowledge

Information

- *"The reduction of uncertainty"*

- Shannon and Weaver, 1948

- *"A representation of a message that is processed into something of value in order to be applied in practice"*

- Pipes, 2006

- Information generation or transmission a major goal of most emerging technologies used in DRR and resilience-building efforts.

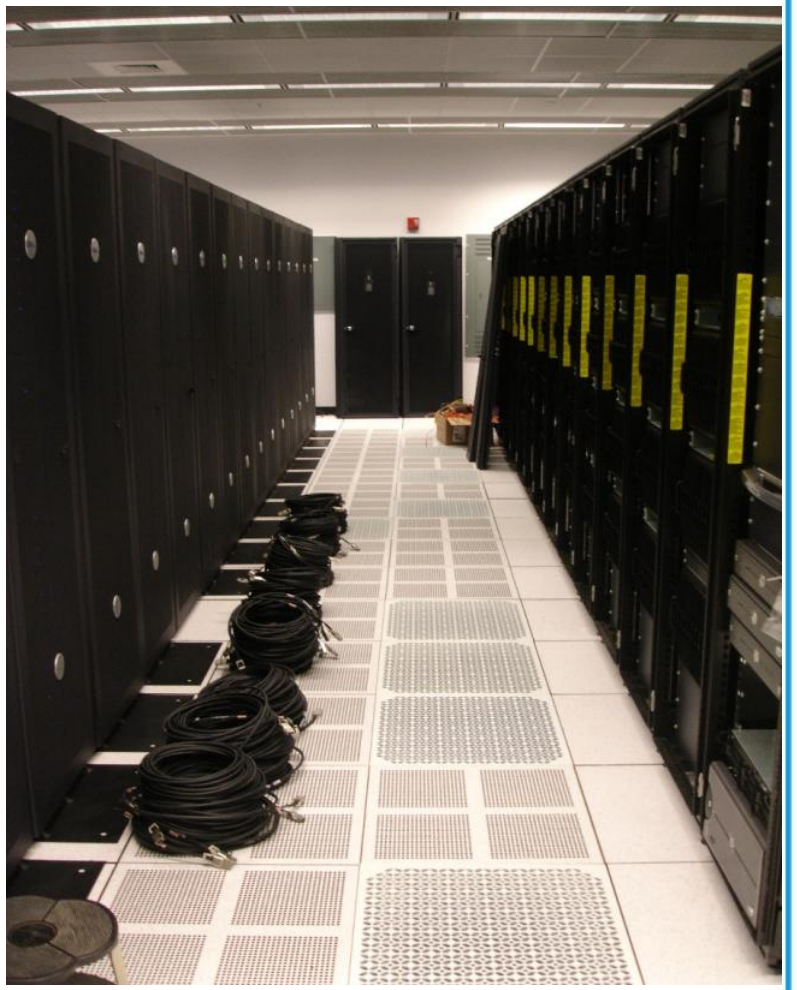


Image: Room filled with data servers.
Image credit: Philip Schatz, 2006.

5. Data and Information for Risk-informed Decision-Making

Types of Knowledge

- **Tacit Knowledge** – Gained through personal experience and therefore lost with the loss of the person who possesses it; it is intuitive, cannot be written down, and is difficult to communicate.
- **Explicit Knowledge** – Can be generated through logical deduction and is easily transmitted to others by articulating, codifying, and storing it into various media; can be written down and is accessible.
- **Implicit Knowledge** - Is not written down yet is not dependant on personal experience or individual context; is more procedural and can simply be implied. Implicit knowledge helps facilitate the performance of new tasks.

Images: Top, Welder; Middle, land surveyor in Bangkok; Bottom, boy pushing wheelbarrow.
Image credit: Top, Per Hortlund, 2011; Middle Mercel Crozet, ILO, 2005; Bottom, Rebecca Smith, 2005.

5. Data and Information for Risk-informed Decision-Making

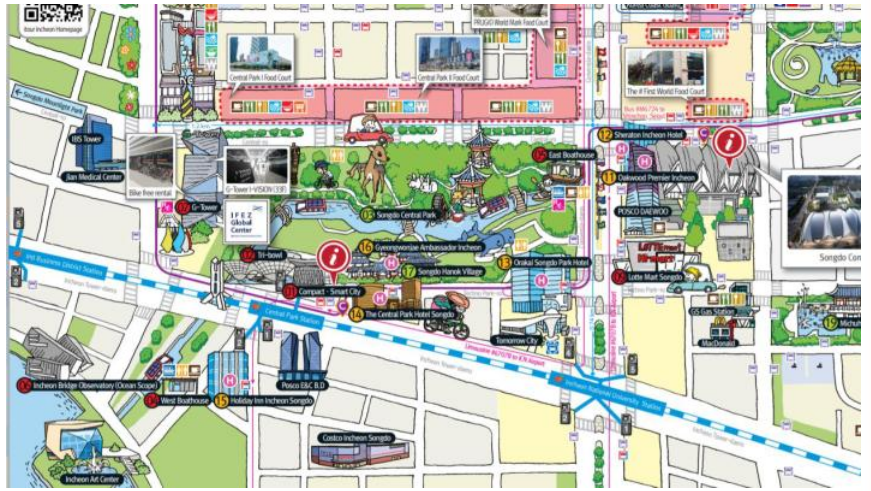
Types of Data / Types of Transactions

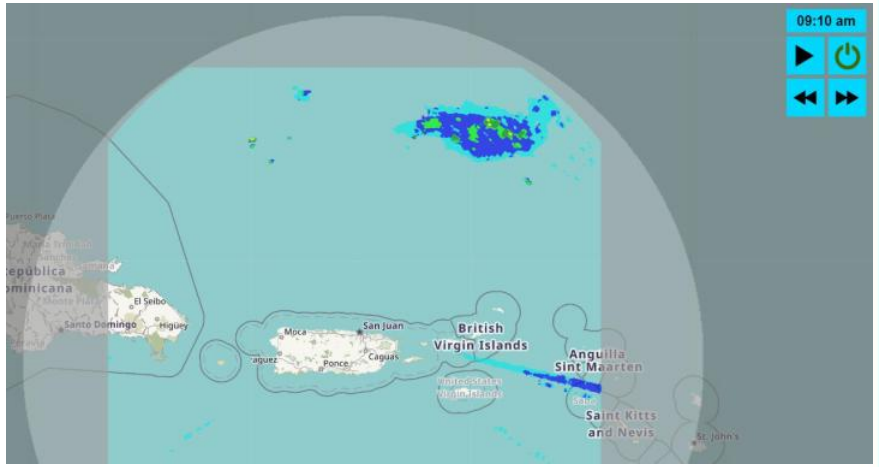
Data Types

- **Static:** Unchanging, not updated regularly
  - Location of buildings
  - A newspaper article
- **Dynamic**: Constantly changing, regularly updated
  - Atmospheric conditions
  - Temperature
  - Precipitation

Transaction Types

- **Formal**: Performed according to a defined schedule or procedure
- **Informal**: performed outside of any established system or structure





Images: Top, tourist map of Songdo, Incheon; Bottom, Doppler Radar map of various Caribbean islands.
Image credit: Top, Visit Incheon, 2019; Bottom, Rain Alarm, 2019.

5. Data and Information for Risk-informed Decision-Making

Open Data

- **Data** that can be "freely used, re-used, and redistributed by anyone."
- **Open Government Data (OGD):** open data in the public domain
- **Sebastopol Principles**:
  - Complete
  - Primary
  - Timely
  - Accessible
  - Machine Processable
  - Non-discriminatory
  - Non-proprietary
  - License-free

Image: Screenshot of PacGeo open data mapping platform.
Image credit: PacGeo, 2019.

5. Data and Information for Risk-informed Decision-Making

Open Data Requirements

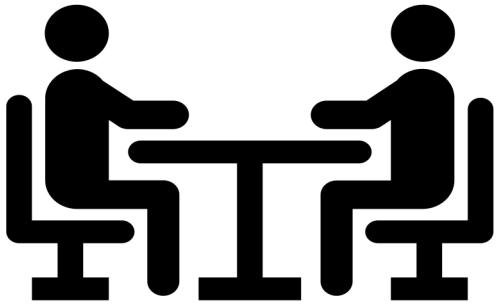
- **Legally Open**
  Explicitly licensed in a way that permits commercial and non-commercial use and re-use without restrictions

- **Technically open**
  Available in a machine-readable standard format, which means it can be retrieved and meaningfully processed by a computer application

	PUBLIC DOMAIN	PUBLIC DOMAIN	BY	BY SA	BY NC	BY ND	BY NC SA	BY NC ND
PUBLIC DOMAIN	✓	✓	✓	✓	✓	✗	✓	✗
PUBLIC DOMAIN	✓	✓	✓	✓	✓	✗	✓	✗
BY	✓	✓	✓	✓	✓	✗	✓	✗
BY SA	✓	✓	✓	✓	✗	✗	✗	✗
BY NC	✓	✓	✓	✗	✓	✗	✓	✗
BY ND	✗	✗	✗	✗	✗	✗	✗	✗
BY NC SA	✓	✓	✓	✗	✓	✗	✓	✗
BY NC ND	✗	✗	✗	✗	✗	✗	✗	✗

Image: Creative Commons licensing matrix.
Image credit: Creative Commons, 2019.

Group Work and Activities



Group Work and Activities

Discussion 4: Open Data

- Is data shared between government ministries or departments in your country? Are there mechanisms that allow open access to government data?

- How is open data advancing sustainable development in your country?
- What do you see as the principal benefits of providing open data access?
  - Benefits from promoting OGD?
  - The facilitators can prompt participants to discuss the existence, quality of, and access to open data, and the types incentives that might help promote open data initiatives to support DRR and resilience efforts vis-à-vis data analytics.

5. Data and Information for Risk-informed Decision-Making

Big Data

- **Volume**
  High volumes of low-density, unstructured data.
- **Velocity**
  The fast rate at which data is received and (perhaps) acted on.
- **Variety**
  The many types of data that are available.

Image: Big Data and the SDGs. Image credit: United Nations, 2019.

5. Data and Information for Risk-informed Decision-Making

Information Sharing Requirements

- Existence of the information
- Quality of the information
- Awareness of the source
- Relationships between stakeholders
- Trust and commitment between stakeholders
- Information coordination and sharing protocols and methodologies
- Information Sharing System Quality
- Institutional capacity to manage information sharing relationships and networks, and to verify and update information as required
- Legal, statutory, and regulatory frameworks to permit and/or foster information sharing

5. Data and Information for Risk-informed Decision-Making

Data-Driven Decision-Making

- Public sector decisions must be defensible
- There is an expanding pool of available data to support decision-making
- **Data-driven governance** requires the "availability of high-quality, timely, and reliable data" (2030 Agenda for Sustainable Development)
- Applicability for data-driven decision-making across all of the SDGs

"Data is the lifeblood of decision-making and the raw material for accountability."

Source: **United Nations. 2019. Big Data for Sustainable Development.** UN Website.. https://www.un.org/en/sections/issues-depth/big-data-sustainable-development/index.html

5. Data and Information for Risk-informed Decision-Making

- **Risk-Informed Decision-Making (RIDM)**

> *"Despite increasing understanding of some complex risks among risk reduction practitioners, global commitments to deliver the Sustainable Development Goals (SDGs) and previously the Millennium Development Goals, development planning and programming still do not adequately consider or act upon these risks."*

Source: Opitz-Stapleton, Sarah, Rebecca Nadin, Jan Kellett, Margherita Calderone, Adriana Quevedo, Katie Peters, and Leigh Mayhew. 2019. Risk-Informed Development: From Crisis to Resilience. ODI, UNDP, and Swiss Agency for Development and Cooperation. http://bit.ly/30UJjJQ.

5. Data and Information for Risk-informed Decision-Making

Risk-Informed Decision-Making (RIDM)

According to the Sendai Framework, DRM requires a **multi-hazard approach** and **inclusive risk-informed decision-making** based on:

- open exchange and dissemination of disaggregated data, including by sex, age and disability.
- DRM also requires easily accessible, up-to-date, comprehensible, science-based, non- sensitive risk information, complemented by traditional knowledge.

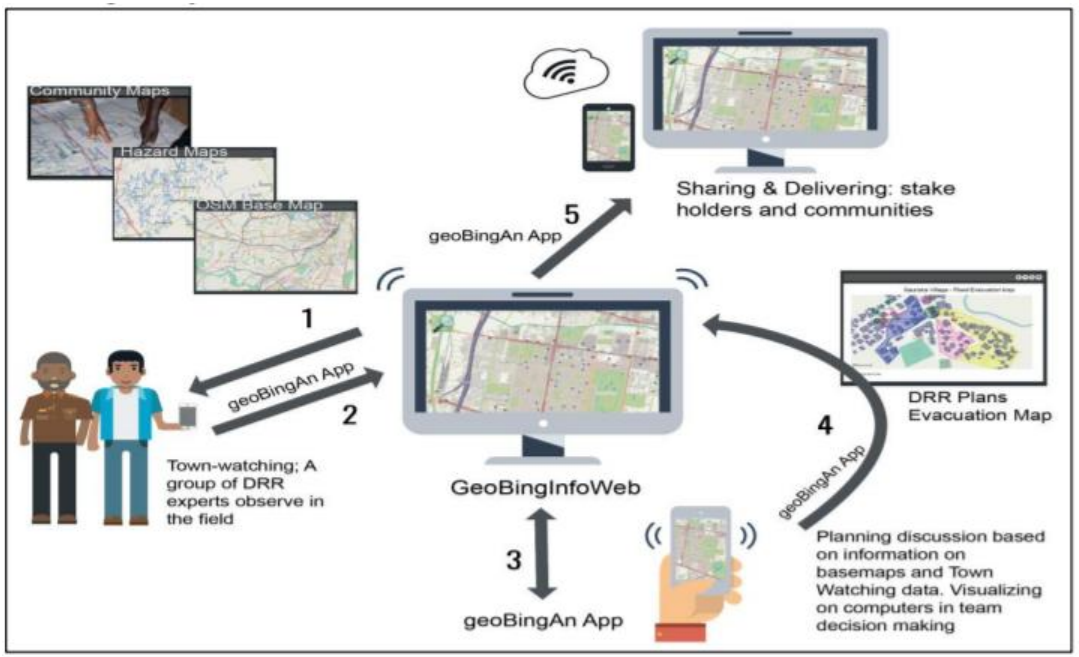
https://www.unapcict.org/sites/default/files/2020-08/Academy%20Module%20on%20ICT%20for%20DRM.pdf

5. Data and Information for Risk-informed Decision-Making

Key activities for Risk-Informed Decision-Making

- **Spatial planning,** which are methods used by governments to influence the future allocation of activities.
- **Planning of risk reduction measures,** which can be structural or non-structural.
- **Design and management of critical infrastructure.** The location of facilities like schools, hospitals, etc. is a strategic spatial planning decision.
- **Risk transfer,** which is the process of formally or informally shifting the financial consequences of particular risks from one party to another

Activity flow of using ICTs in community-based preparedness planning in Fiji



https://www.unapcict.org/sites/default/files/2020-08/Academy%20Module%20on%20ICT%20for%20DRM.pdf

5. Data and Information for Risk-informed Decision-Making

ICT and E-Government Tools for Alerting and Evacuating

ShakeAlert – An App for Earthquake Warning

- One of the logical developments of ICT for disaster preparedness is the **design of apps to assist citizens** in the preparedness phase.
- To **raise their awareness of the risks** in their area**, inform them about what to do** in case of an emergency.
- **Alert them of possible hazard events**, or guide them to evacuate.

Source: USGS, "Earthquake Hazards: Early Warning".
Available at https://www.usgs.gov/natural-hazards/earthquake-hazards/early-warning.

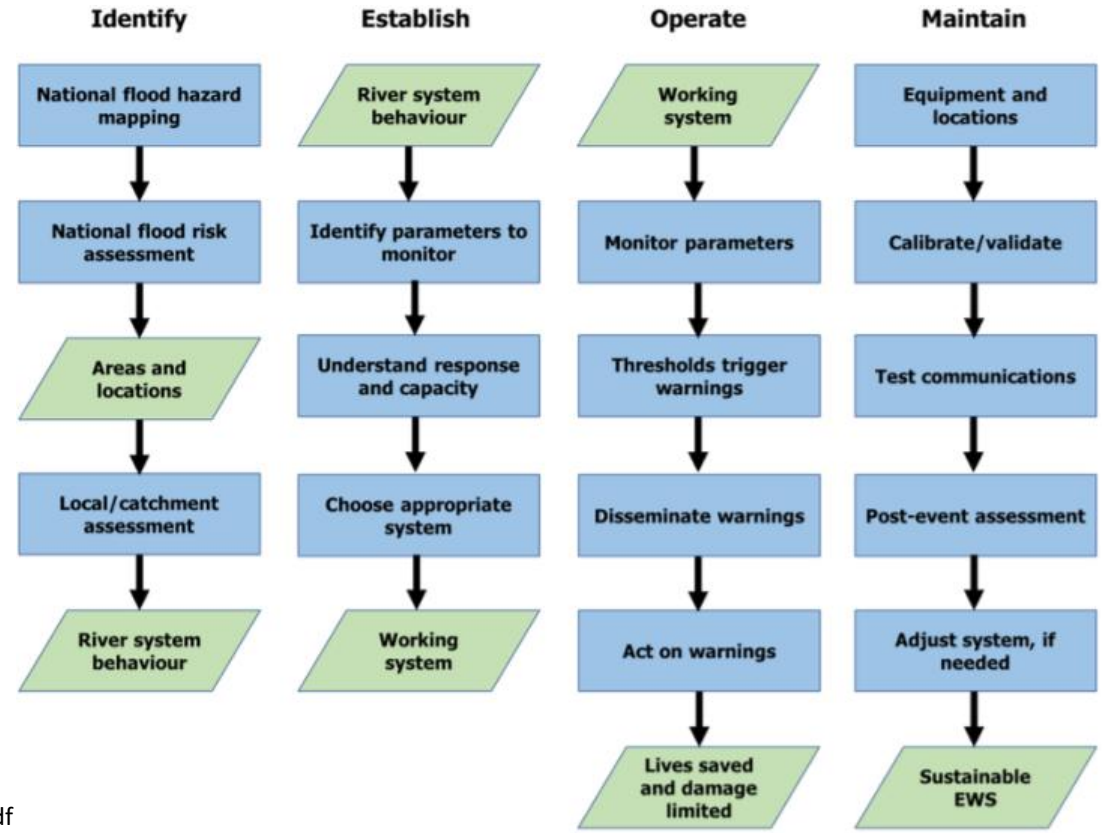
https://www.unapcict.org/sites/default/files/2020-08/Academy%20Module%20on%20ICT%20for%20DRM.pdf

5. Data and Information for Risk-informed Decision-Making

ICT and E-Government for Early Warning

- Early warning systems (EWS) are one of the important elements of disaster preparedness
- **Four elements in natural hazard EWS**:
  - ***Risk knowledge***
  - ***Monitoring and warning service***
  - ***Dissemination and communication***
  - ***Response capability***

Schematic Representation of Components of a flood EWS



https://www.unapcict.org/sites/default/files/2020-08/Academy%20Module%20on%20ICT%20for%20DRM.pdf

6. Inherent Limitations, Challenges, and Risks

"In many cases, technology is the easiest part. The challenge is to create a long-term, digital foundation for humanitarian organizations that enables them to invest in, test and scale technology solutions prior to disasters so they are prepared when they need it the most.

While technology cannot replace the vital resources people need in disaster – food, water, shelter, or comfort from loved ones - it is transforming disaster relief efforts and paving the way for an evolving approach to international aid: one that can reach more people, faster, and help communities to develop resilience for when the next disaster strikes."

Image: Thousands of unused bike share bicycles; Xiamen, Fujian, China.
Image credit: Reuters, 2018.

6. Inherent Limitations, Challenges, and Risks

Limitations

- **Reason**
  Computers and machines have no capacity for reason
- **Emotion**
  Computers and machines lack genuine human emotion
- **Morality**
  Computers and machines lack any real or innate sense of morality
- **Real-world experience**
  Computers and machines lack the real-world experience that practitioners gain through their years or decades of first-hand work

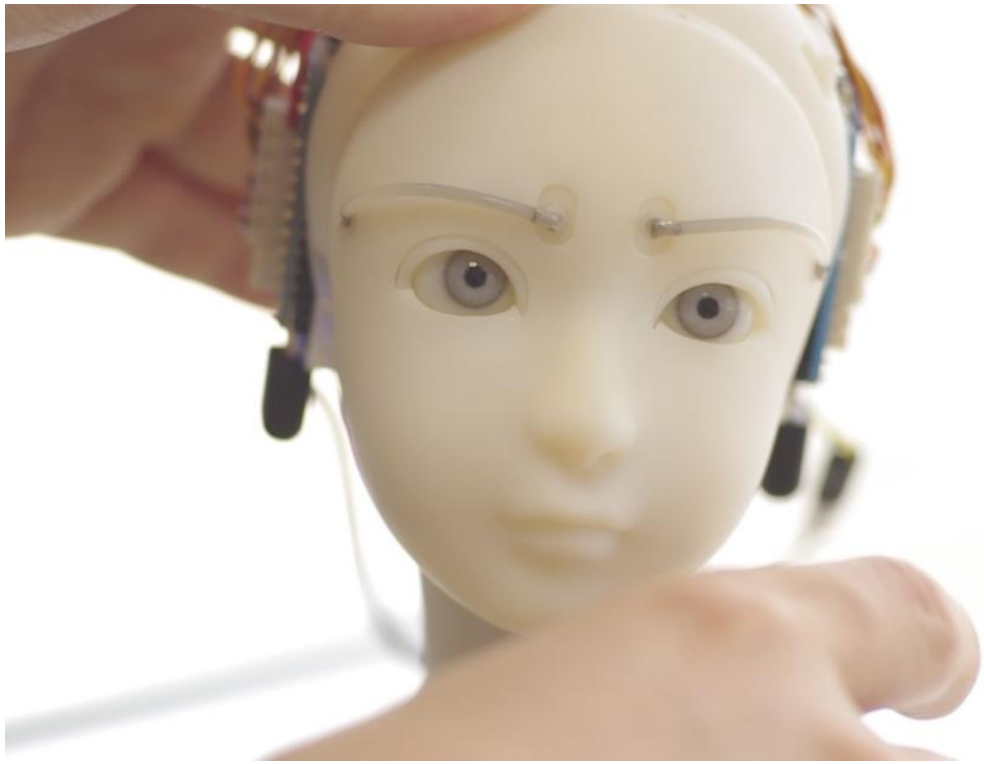
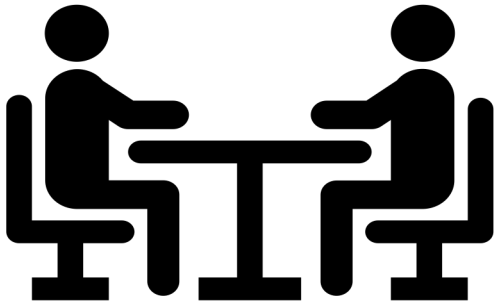


Image: SEER Simulative Emotional Expressive Robot.
Image credit: Takayuki Todo, 2018.

Group Work and Activities



Discussion 5: Limitations of Technologies and Innovations

- The instructional team can ask participants to create a short list of technologies that have become a common part of life throughout the world. Examples include:
  - ATM Machines
  - Robotic vacuum cleaners
  - Virtual Assistants (e.g., Amazon Alexa, Hey Google, Siri, Cortana)
- Discuss how these improve on what a human can feasibly do.
- Discuss how humans remain better capable than these technologies
- In light of these limitations, is this a good technology / innovation?

6. Inherent Limitations, Challenges, and Risks

Challenges and Obstacles

- Financial Costs
- Infrastructure dependencies
- Data
- Reach
- Fit
- Human capacity
- Confidence and trust
- Bureaucratic climate / restrictive policies
- Last-mile delivery

Image: Damage to seaports and waterways in Port-au-Prince was extensive following the 2010 Haiti Earthquake. Air and seaport damage can make the movement of some technologies difficult in the earliest hours and days of a disaster. Image credit: US Coast Guard Press, 2010.

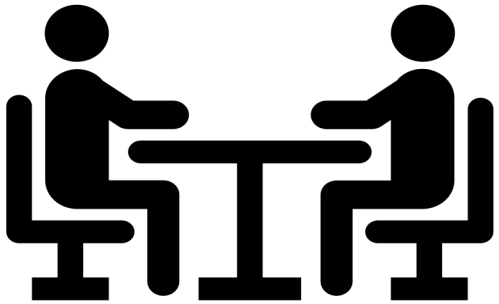
6. Inherent Limitations, Challenges, and Risks

- **Risks**

  - Safety or security
  - Social impacts
  - Increased complexity / risk of total failure
  - Brain drain

Image: Hermes 450 surveillance and communications drone after a crash.
Image credit: Think Defence, 2018.

Group Work and Activities



Discussion 6: Risks Associated with Technologies and Innovations

- Using the technologies previously discussed, participants can create discuss risks that may arise through the adoption of each identified technology or with one that the facilitators select.

- Participants should identify risks and explain their origin, the likely impact they will have, and any options that exist to manage those risks.

Background Materials

Key Readings	• United Nations. 2020. E-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development. Department of Economic and Social Affairs. New York. https://bit.ly/2E4gZ2q • United Nations. 2019. The Role of Science, Technology, and Innovation in Building Resilient communities, Including Through the Contribution of Citizen Science. Economic and Social Commission. Commission on Science and Technology for Development. May 13-17. Geneva. http://bit.ly/2MlB46z • United Nations. 2018. E-Government Survey 2018: Gearing E-Government to Support Transformation Towards Sustainable and Resilient Societies. Department of Economic and Social Affairs. New York. http://bit.ly/2SsKvl4 [Chapter 1] • United Nations. 2020. ICT for Disaster Risk Management – Academy of ICT Essentials for Government Leaders[https://www.unapcict.org/sites/default/files/2020-08/Academy%20Module%20on%20ICT%20for%20DRM.pdf • World Economic Forum. 2020. Smart at Scale: Cities to Watch, 25 Case Studies, COMMUNITY PAPER.http://www3.weforum.org/docs/WEF_Smart_at_Scale_Cities_to_Watch_25_Case_Studies_2020.pdf


Thank you