



Climate Change: Impacts, Adaptation & Vulnerability (Reference: IPCC Third Assessment Report)

Emergent Finding 1

Recent Regional Climate Changes, particularly Temperature Increases, have already affected many Physical and Biological Systems

Examples :

- shrinkage of glaciers
- thawing of permafrost
- later freezing & earlier breaking of ice on rivers and lakes
- lengthening of mid-to high-latitude growing seasons
- poleward & altitudinal shifts of plant & animal ranges
- declines of some plant and animal populations
- earlier flowering of trees
- emergence of insects
- egg-laying in birds

Emergent Finding 1(contd.)

- **Methodology of Assessment : Systematic long-term studies (atleast 20 years)**
- **Causes: Collective evidence from factors (such as LUC,pollution, ecosystem data) indicates a high confidence between temperature change and these impacts**

Emergent Finding 2

- **There are Preliminary Indications that Some Human Systems have been Affected by Recent Increases in Floods and Droughts**
- **Examples: social and economic systems**
- **Factors: increasing frequency of floods and droughts in some areas**
- **Methodology: Long term observations generally difficult to quantify impacts**

Emergent Finding 3

Natural Systems are Vulnerable to Climate Change, and some will be Irreversibly Damaged

Reason: limited adaptive capacity

Examples:

- glaciers
- coral reefs and atolls
- mangroves
- boreal and tropical forests
- polar and alpine ecosystems
- prairie wetlands
- remnant native grasslands
- biodiversity

Emergent Finding 4

Many Human Systems are Sensitive to Climate Change, and Some are Vulnerable

Examples

- water resources
- agriculture (esp. food security)
- forestry
- coastal zones
- marine systems (fisheries)
- human settlements
- industry
- other financial services
- human health

Methodology: models and other studies

Emergent Finding 5

Projected Changes in Climate Extremes could have Major Consequences

Reason: increase in frequency and/or severity during the 21st century due to changes in the mean and/or variability of climate

Examples

- Droughts
- floods
- heat waves
- Avalanches
- windstorms

Emergent Finding 6

The Potential for Large-Scale and Possibly Irreversible Impacts Poses Risks that have yet to be Reliably Quantified

Examples

- significant slowing of the ocean circulation
- large reductions in the Greenland and West Antarctic Ice Sheets
- accelerated global warming due to carbon cycle feedbacks in the terrestrial biosphere
- releases of terrestrial carbon from permafrost regions and methane from hydrates in coastal sediments

Emergent Finding 7

Adaptation is a Necessary Strategy at All Scales to Complement Climate Change Mitigation Efforts

Reason: to reduce adverse impacts of climate change and to enhance beneficial impacts, but will incur costs and will not prevent all damages

Key Factors

- Extremes
- Variability
- rates of change

Planned adaptation can supplement autonomous adaptation

Emergent Finding 8

Those with the Least Resources have the Least Capacity to Adapt and are the Most Vulnerable

- **Adaptation:** depends upon wealth, technology, education, information, skills, infrastructure, access to resources, and management capabilities

- **Cost Benefit Analysis generally exclude effects of**
 - changes in climate variability and extremes
 - different rates of change
 - goods and services not traded

- **These Omissions**
 - underestimate economic losses and overestimates of economic gains
 - gains for some used to cancel losses for others, which assumes perfect equity

Emergent Finding 9

Adaptation, Sustainable Development, and Enhancement of Equity can be Mutually Reinforcing

Regions vulnerable to climate change also have

- population pressure
- resource depletion
- poverty

Policies to tackle these also improve

- sustainable development and equity
- enhance adaptive capacity
- reduce vulnerability to climate change

Effects on and Vulnerability of Natural and Human Systems

- Hydrology and Water Resources
- Agriculture and Food Security
- Terrestrial and Freshwater Ecosystems
- Coastal Zones and Marine Ecosystems
- Human Health
- Human Settlements, Energy, and Industry
- Insurance and Other Financial Services

1. Hydrology and Water Resources

- The effect of climate change climate follows projected changes in precipitation.
 - A consistent projection across climate change scenario is increases in annual mean stream flow in high latitudes and southeast Asia, and decreases in central Asia
- The projected changes in average annual runoff are less robust than impacts based solely on temperature change
- Climate change is unlikely to have a big effect on municipal and industrial water demands in general, but may substantially affect irrigation withdrawals
 - High temperature leads to high crop evaporative demand and hence high irrigation demand

2. Agriculture and Food Security

Crop yield responses to climate change depend upon

- **species and cultivar**
- **soil properties**
- **pests, and pathogens**
- **the direct effects of carbon dioxide (CO₂) on plants**
- **interactions between CO₂, air temperature, water stress, mineral nutrition, air quality, and adaptive responses**

When autonomous agronomic adaptation is included, climate change will lead to generally positive responses at less than a few °C warming and generally negative responses for more than a few °C in yields of some crops in mid-latitude and tropical locations

2. Agriculture and Food Security(contd.)

Economic modeling assessments indicate that impacts of climate change on agricultural production and prices result in:

- **small percentage changes in global income (low confidence),**
- **larger increases in more developed regions**
- **smaller increases or declines in developing regions**

3. Terrestrial and Freshwater Ecosystems

Vegetation modeling studies continue to show the potential for significant disruption of ecosystems under climate change

- poleward movement of the boundaries of freshwater fish distributions
- loss of habitat for cold- and cool-water fishes and gain in habitat for warm-water fishes

Possible adaptation methods to reduce risks to species include:

- establishment of refuges, parks, and reserves with corridors to allow migration of species
- use of captive breeding and translocation

4. Coastal Zones and Marine Ecosystems

Large-scale impacts of climate change on oceans include

- increases in sea surface temperature and mean global sea level
- decreases in sea-ice cover
- changes in salinity, wave conditions, and ocean circulation

Impacts of climate change on coastal areas include

- increased levels of flooding
- accelerated erosion
- loss of wetlands and mangroves and seawater intrusion into freshwater sources
- increase in the extent & severity of storm impacts

4. Coastal Zones & Marine Ecosystems (contd.)

Impacts on highly diverse and productive coastal ecosystems depend upon

- the rate of sea-level rise relative to growth rates and sediment supply
- space for and obstacles to horizontal migration
- changes in the climate-ocean environment such as sea surface temperatures and storminess
- pressures from human activities in coastal zones

Adaptation options for coastal and marine management are effective with policies in other areas, such as disaster mitigation plans and land-use plans

5. Human Health

Many vector-, food-, and water-borne infectious diseases are known to be sensitive to changes in climatic conditions

In all cases, actual disease occurrence is strongly influenced by

- **local environmental conditions**
- **socioeconomic circumstances**
- **public health infrastructure**

Projected climate change will be accompanied by

- **an increase in heat waves, often exacerbated by increased humidity**
- **urban air pollution causing an increase in heat-related deaths and illness episodes**

5. Human Health (contd.)

- **Impacts due to extreme events**
- **Increase in flooding further increasing the risk of drowning, diarrhoeal and respiratory diseases, and, in developing countries, hunger and malnutrition**
- **Regional increase of cyclones leaving devastating impacts on densely settled populations with inadequate resources.**
- **A reduction in crop yields and food production in the tropics predisposing food-insecure populations to malnutrition, leading to impaired child development and decreased adult activity**
- **Socioeconomic disruptions could occur in some regions, impairing both livelihoods and health.**

5. Human Health (contd.)

Social, institutional, technological, and behavioral adaptation options to lessen the adverse health impact encompass:

- **strengthening of the public health infrastructure**
- **health-oriented management of the environment (including air and water quality, food safety, urban and housing design, and surface water management)**
- **the provision of appropriate medical care facilities**

6. Human Settlements, Energy, and Industry

Human settlements affected by climate change :

- **the economic sectors supporting the settlements, due to changes in resource productivity or changes in market demand for the goods and services produced there**
- **physical infrastructure (including energy transmission and distribution systems), buildings, urban services (including transportation systems), and specific industries (such as agro industry, tourism, and construction)**
- **population through extreme weather, changes in health status, or**
- **migration**

Riverine, coastal and urban settlements are highly vulnerable to climate change

6. Human Settlements, Energy, and Industry (contd.)

Direct risk to human settlements from climate change

- flooding and landslides
- projected increases in rainfall intensity
- sea-level rise in coastal areas

Settlements with little economic diversification and where a high percentage of incomes derive from climate-sensitive primary resource industries (agriculture, forestry, and fisheries) are more vulnerable than more diversified settlements

Possible adaptation options:

- planning of settlements and their infrastructure
- placement of industrial facilities
- and making similar long-lived decisions

7. Insurance and Other Financial Services

upward trend in disaster losses is linked to

- **socioeconomic factors: population growth, increased wealth, and urbanization in vulnerable areas**
- **climatic factors: the observed changes in precipitation and flooding events**

anticipated changes in weather-related events would trigger

- **increased insurance costs, slow the expansion of financial services into developing countries, reduce the availability of insurance for spreading risk, and increase the demand for government-funded compensation following natural disasters**

7. Insurance and Other Financial Services (contd.)

Possible adaptation options:

- Public- and private-sector actors support adaptation by
 - promoting disaster preparedness
 - loss-prevention programs
 - building codes
 - improved land-use planning

Other options

- extensive access to insurance
- more widespread introduction of micro-financing schemes
- and development banking

Vulnerability Varies across Regions

The impacts, adaptive capacity and vulnerability of human populations and natural systems to climate change differs substantially across regions and across populations within regions because:

- The natural and social systems of different regions have varied characteristics, resources, and institutions, and are subject to varied pressures

Most less-developed regions are vulnerable to climate change because:

- larger share of their economies in climate-sensitive sectors
- low adaptive capacity due to low levels of human, financial, and natural resources, as well as limited institutional and technological capability