



GCOS

GLOBAL CLIMATE OBSERVING SYSTEM

Role and Value of Systematic Observations in Adaptation

From end to end:
From climate observations to decisions

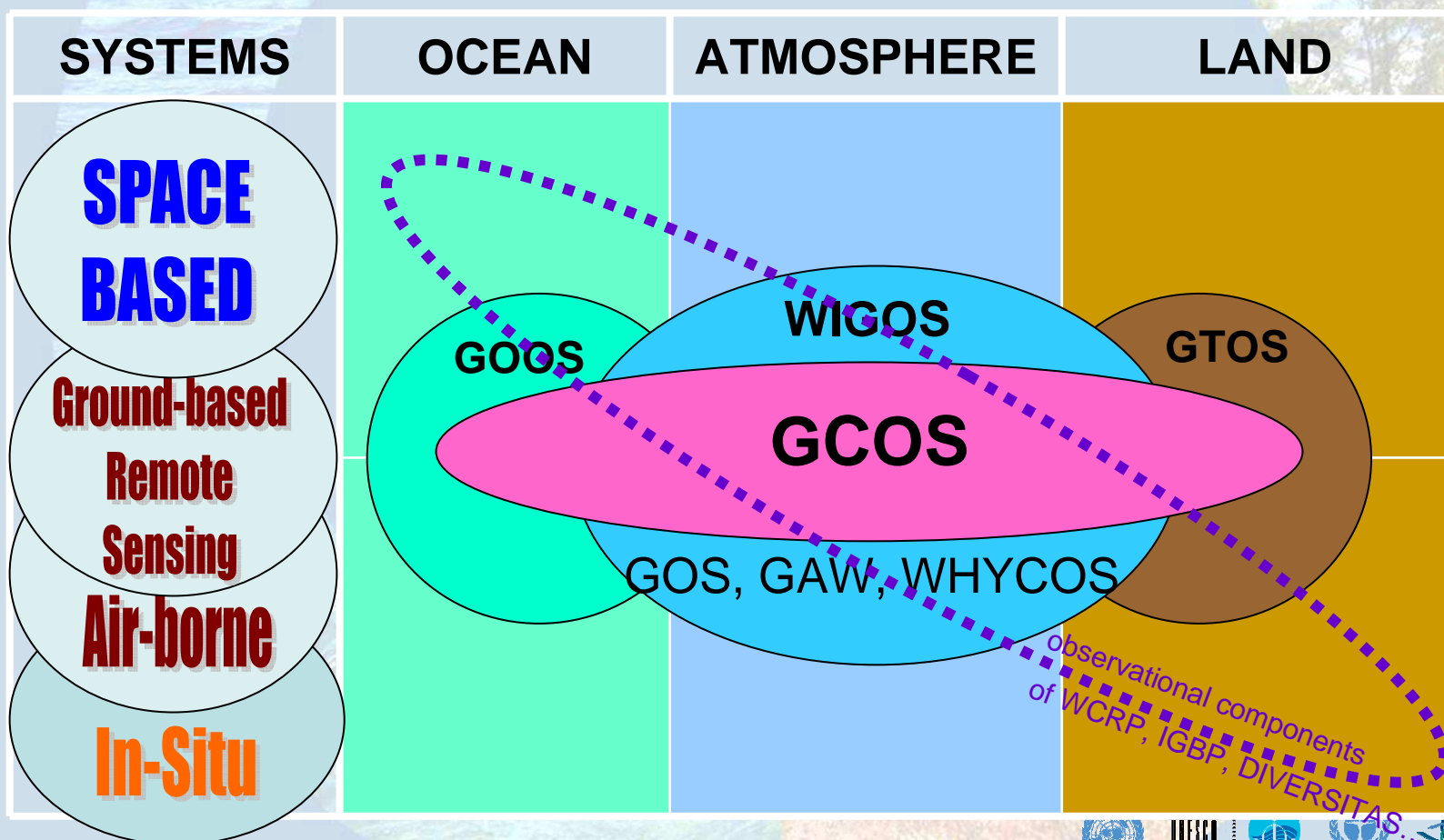
08 June 2011, Bonn, SBSTA34, Germany
Dr Carolin Richter, Director, Global Climate Observing System Secretariat



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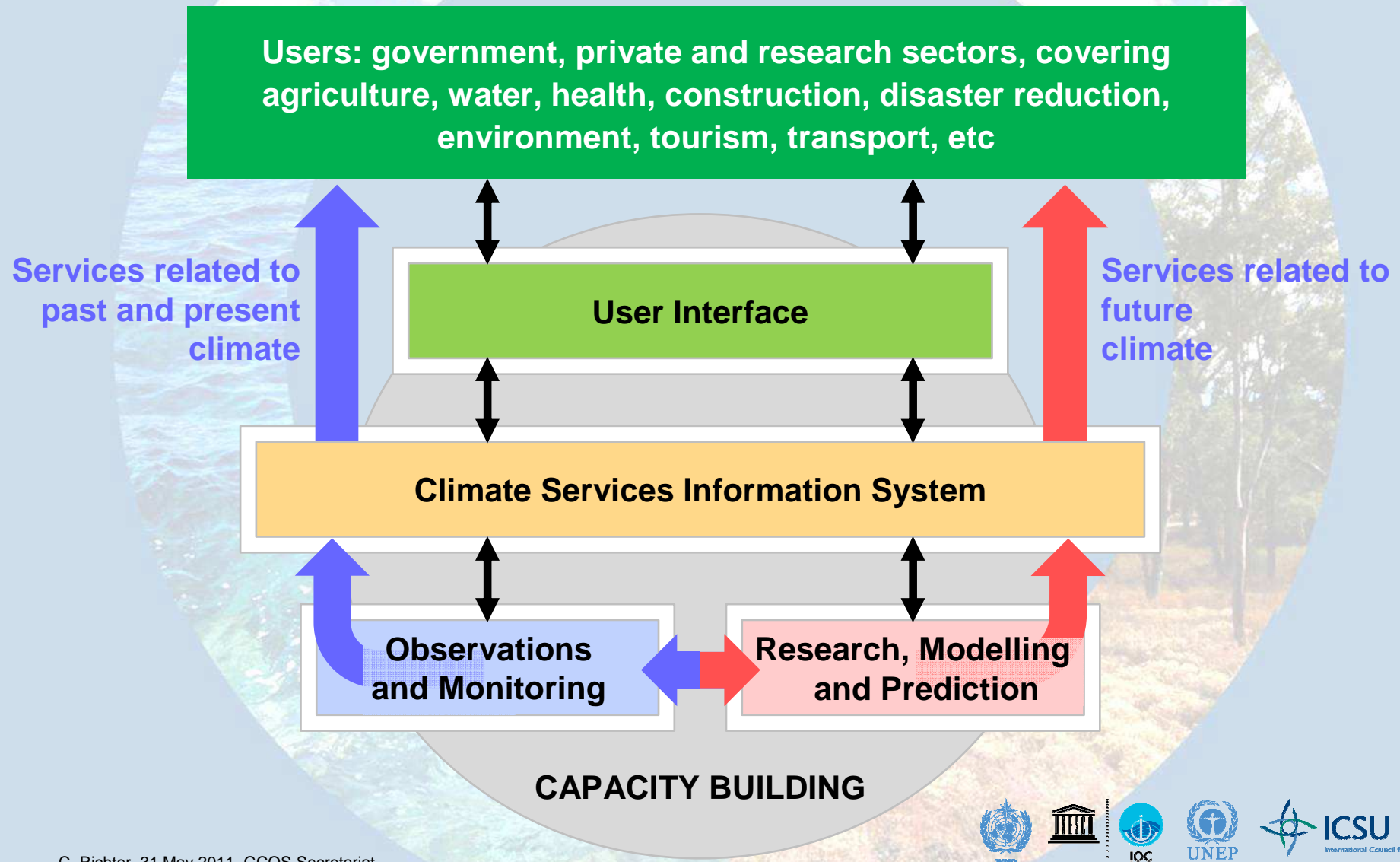
GCOS is a System of Systems

The Composition and Scope of the Main Global Observing Systems



GCOS as a Component of the Global Framework for Climate Services - GFCS

(Figure taken from Prof. A. Simmons, GFCS II side event, Cg-XVI, 19 May 2011)



GCOS Essential Climate Variables (ECVs)

- Atmospheric

- **Surface** – Air temperature, **Precipitation**, Pressure, Surface radiation budget, **Wind speed and direction**, Water vapour
- **Upper Air** – Earth radiation budget (including solar irradiance), Temperature, Wind speed and direction, Water vapour, Cloud properties
- **Composition** – Carbon dioxide, Methane and other long-lived greenhouse gases (N₂O, CFCs, HCFCs, HFCs, SF₆ and PFCs), Ozone and Aerosol, **supported by their precursors** (NO₂, SO₂, HCHO and CO).

- Oceanic

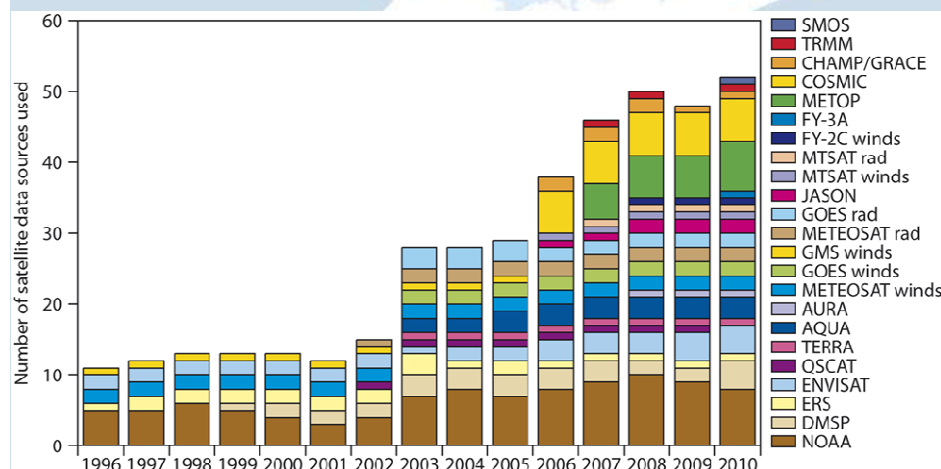
- **Surface** – Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface Current, Ocean colour, Carbon dioxide partial pressure, **Ocean acidity**, Phytoplankton.
- **Sub-surface**: Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, **Ocean acidity**, **Oxygen**, Tracers.

- Terrestrial

- River discharge, Water use, Ground water, **Lakes**, **Snow cover**, **Glaciers and ice caps**, **Ice sheets**, Permafrost and seasonally-frozen ground, **Albedo**, **Land cover** (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), **Above ground biomass**, **Soil carbon**, Fire disturbance, **Soil moisture**.

Blue/bold = largely space-based **red** = new in 2010 plan

Observations improve Quality of Forecasts



Increased number of satellite data

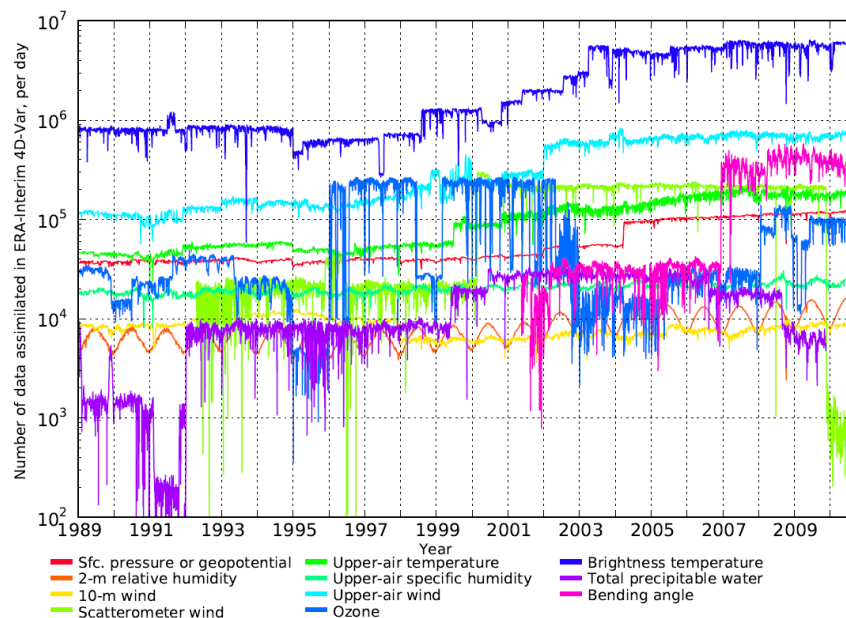
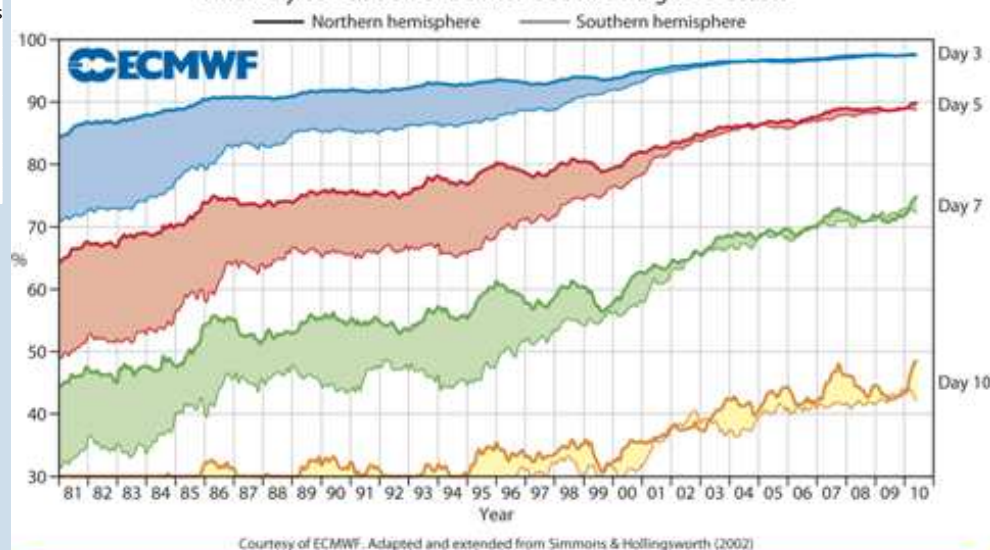


Figure 10: Timeseries of the daily count of observations assimilated in the ERA-Interim atmospheric analysis
C. Richter, 31 May 2011, GCOS Secretariat



Great Advances in Global and Regional Weather Forecasts

Anomaly correlation of ECMWF 500 hPa height forecasts

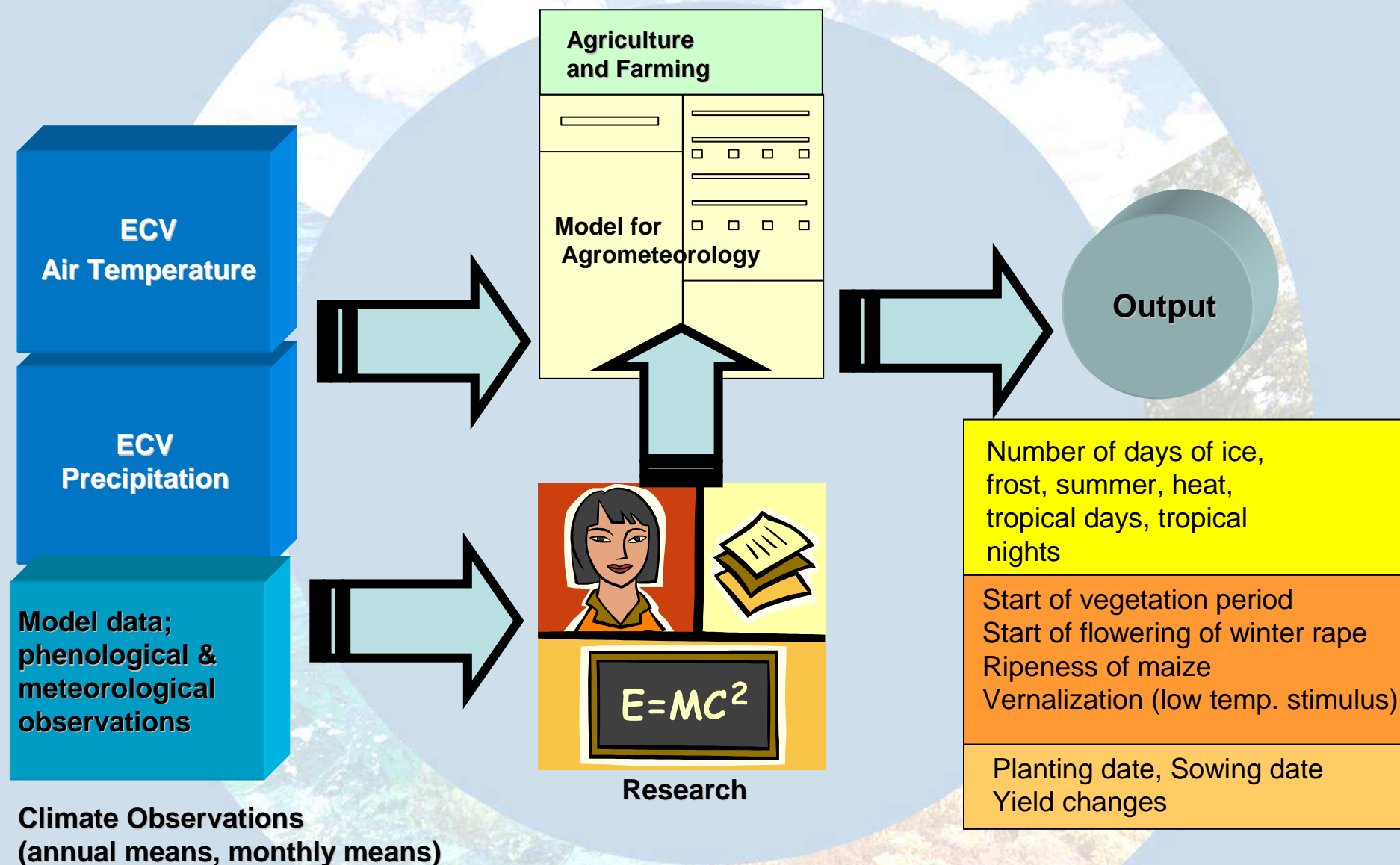


Increase of overall number of data assimilated in ERA-interim by a factor of 10 between 1989 and 2010



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From Observations to Information to Services



Risk Management – Early Warning Systems

NATURAL HAZARDS

Some natural hazards are weather events (tropical and extra-tropical cyclones, tornadoes, thunderstorms, lightning, hailstorms, high winds, snow storms, freezing rain, dense fog, thermal extremes and drought). Others are related to weather, climate and water (floods and flash floods, storm surges, high waves at sea, sand- or duststorms, forest or bush fires, smoke and haze, landslides and mudslides, avalanches and desert locust swarms).

Time- and space-scales of hazards

Each hazard is in some way unique. Tornadoes and flash floods are short-lived, violent events, affecting a relatively small area. Others, such as droughts, develop slowly, but can affect most of a continent and entire populations for months or even years.

Multiple hazards

An extreme weather event can involve multiple hazards at the same time or in quick succession. In addition to high winds and heavy rain, a tropical storm can result in flooding and mudslides. In temperate latitudes, severe summer weather (thunder and lightning storms or tornadoes) can be accompanied by heavy hail and flash floods. Winter storms with high winds and heavy snow or freezing rain can also contribute to avalanches on some mountain slopes and to high runoff or flooding later on in the melt season.

Geophysical hazards

Some National Meteorological and Hydrological Services and specialized centres have responsibility for investigating geophysical hazards including volcanic eruptions (airborne ash) and tsunamis, and hazardous airborne matter (radioisotopes, biological and chemical substances) and acute urban pollution.

DUSTSTORMS/ SANDSTORMS

Duststorms and sandstorms are onsets of particles of dust or sand lifted to great heights by strong and turbulent wind. They occur mainly in parts of Africa, Australia, China and the USA. They threaten lives and health, especially of persons caught in the open and far from shelter.

Transportation is particularly affected as visibility is reduced to only a few metres.

THUNDERSTORMS, LIGHTNING, TORNADES

Severe thunderstorms give rise to sudden electrical discharges in the form of lightning and thunder. They often bring heavy rain or hail, strong winds and occasionally snow.

In some parts of the world they trigger tornadoes. Tornadoes are particularly common in the Great Plains of North America but they can also occur anywhere, especially in temperate latitudes. They can cause severe damage. Other associated phenomena include downbursts and flash floods.

Workdays, lightning during dry periods is a significant factor in starting wildfires in forests and grasslands.

HEAVY RAIN AND SNOW, STRONG WINDS

Heavy rain and snow are dangerous for vulnerable communities. They can exacerbate rescue and rehabilitation activities after a major disaster, such as the earthquake in Pakistan in October 2005. They bring havoc to road and rail transportation, infrastructure and communication networks. An accumulation of snow can cause the roofs of buildings to collapse.

Strong winds are a danger for aviation, sailors and fishermen, as well as for tall structures such as towers, masts and cranes.

Blizzards are violent storms combining below-freezing temperatures with strong winds and blowing snow. They are a danger to people and livestock. They cause airports to close and bring havoc to roads and railways.

FLOODS AND FLASH FLOODS

Floods can occur anywhere after heavy rain events. All floodplains are vulnerable and heavy storms can cause flash flooding in any part of the world. Flash floods can also occur after a period of drought when heavy rain falls onto very dry, hard ground that the water cannot penetrate.

Floods come in all sorts of forms, from small flash floods to sheets of water covering huge areas of land. They can be triggered by severe thunderstorms, tornadoes, tropical and extra-tropical cyclones (many of which can be exacerbated by the El Niño phenomenon), monsoons, ice jams or melting snow.

In coastal areas, storm surge caused by tropical cyclones, tsunamis, or waves swollen by exceptionally high tides can cause flooding. Dikes can flood when the waves forcing them carry large amounts of seawater. Dam breaks or sudden regulatory operations can also cause catastrophic flooding.

Floods threaten human life and property worldwide. Some 1.5 billion people were affected by floods in the last decade of the 20th century.

LANDSLIDE OR MUDSLIDE (MUDFLOW)

Mudslides and landslides are local events and usually unexpected. They occur when a heavy rain or rapid snow or ice melt or an overtopping of a lake sends large amounts of earth, rock, sand or mud flowing swiftly down mountain slopes, especially if these are bare or burnt by forest or brush fires.

They can reach speeds of over 100 km/h and can bury, crush or carry away people, objects and buildings. In Venezuela in 1999, after two weeks of continuous rain, landslides and mudflows slid down a mountain, washing away towns and killing an estimated 15 000 people.

THERMAL EXTREMES

Hott waves are most deadly in mid-latitude regions, where they concentrate extremes of temperature and humidity over a period of a few days in the warmer months. The oppressive air mass in an urban environment can result in many deaths, especially among the very young, the elderly and the infirm.

In 2003, much of western Europe was affected by heat waves during the summer months. In France, Italy, The Netherlands, Portugal, Spain and the United Kingdom, they caused some 40 000 deaths.

Extremely cold spells cause hypothermia and aggravate circulatory and respiratory diseases.

HAILSTORMS, ICE STORMS

Precipitation in the form of large hailstones can reach diameters of over 10 cm and can fall at speeds of over 100 km/h. Widespread losses to agriculture in a typical year are more than US\$ 200 million. Hailstorms have also caused deaths and great damage to cities around the world.

In a matter of minutes an ice storm can deposit a layer of ice heavy enough to bring down power and telephone lines and snap branches from trees. The ice covers roads, rail tracks, and runways, making driving extremely hazardous, delaying trains, and closing airports.

TROPICAL CYCLONES

Tropical cyclones are areas of very low atmospheric pressure over tropical and sub-tropical waters which build up into a huge, circulating mass of wind and thunderstorms up to hundreds of kilometres across. Surface winds can reach speeds of 200 km/h or more.

About 80 tropical cyclones form every year. Their names depend on where they form: typhoons in the western North Pacific and South China Sea; hurricanes in the Atlantic, Caribbean and Gulf of Mexico; and in the eastern North and Central Pacific Oceans and tropical cyclones in the Indian Ocean and South Pacific region.

HAZARDS

WEATHER CLIMATE WATER

DESERT LOCUSTS

Desert locusts inflict damage in Africa, the Middle East, Asia and southern Europe. When weather and ecological conditions favour breeding, the insects are forced into a small area. They stop acting as individuals and start acting as a group. Within a few months, huge swarms form and fly downwind in search of food.

Swarms can be dozens of kilometres long and travel up to 200 km a day. A small part of an average swarm for about one hour of locusts will eat the same amount of food in one day as 10 elephants or 25 camels or 2 500 people. They jeopardize the lives of millions of farmers and herders in already fragile environments.

Locust plagues during or immediately after drought conditions can spell even greater disaster, as was the case in several Sahelian countries in 2005.

AIR POLLUTION

Pollutants include particulate matter and noxious gases from industry, vehicles and human activities.

Smoke and haze result from forest or woodland fires or from slash-and-burn forest or crop clearing or ash from volcanic eruptions in stable air conditions. Smoke, haze and pollution have serious implications for human health—the local population may have to wear gas masks. They reduce visibility, air and road traffic can be disrupted.

Smog, acid rain, the ozone hole and an adverse increase in the greenhouse effect are also caused by air pollution. Stable atmospheric conditions often lead to a concentration of pollutants.

DROUGHT

The primary cause of any drought is deficiency of rainfall. Drought is different from other hazards in that it develops slowly, sometimes over years, and its onset can be masked by a number of factors. In some cases, droughts are recognized too late for emergency measures to be effective.

Drought can be devastating: water supplies dry up, crops fail to grow, animals die and malnutrition and ill health become widespread. Drought is often associated with the arid regions of Africa, particularly the Sahel. In recent years, droughts have also struck India and parts of China, the Middle East, Australia, parts of North America, and Europe.

ENVIRONMENTAL DEGRADATION

Storms erode beaches and coasts. They cause damage to fragile and often unique ecosystems such as mangroves and coral reefs. Warmer temperatures bleach corals and place animal, plant and bird species at risk from extinction. These impacts not only cause a loss of biodiversity, they also put livelihoods at risk, not least in the tourism sector.

Rising sea-level and flooding increase saltwater intrusion into surface and groundwater sources.

FOG AND SMOG

Fog is a suspension of very small, usually microscopic, water droplets in the air.

Dense fog has a serious impact on transportation when the visibility is significantly reduced. Highways, airports and ports are closed for safety. Fog can cause considerable economic losses.

Smog is a combination of fog and air pollution. It has serious implications for human health.

FOREST OR WILDLAND FIRE

Massive and devastating fires can be triggered during and after periods of drought, by lightning or by human action in almost all parts of the world. As well as destroying forests, grasslands and crops, they kill livestock and wild animals, damage or destroy settlements and put the lives of inhabitants at risk.

Elements of Risk Management:
historical climate record, EWS, Insurance tools

“Early warning systems help in foreseeing and responding to future weather and climate variations and their warnings and predictions can be directly integrated into decision making processes.”

(Source: HLT on GFCS Report “Climate Knowledge for Action, p. 28”)

What kind of decisions need to be made in particular sectors if they are based on specific forecast / prediction models (time scales)?

2050 and beyond = Climate Change (Emission Scenarios)	Strategic Thinking on how to adapt the relevant policies <div> <div>Land use Reproductivity capacity of stocks</div> <div>Water reserves Coastal lines, Shipping ways, Planning policies</div> <div>Purchasing&stock policies</div> </div>
Decadal 10 yrs Inter-Decadal (10-20 yrs) Mult-Decadal (> 20 yrs) (PDO,AMO,MOC)	Long-term Planning <div> <div>Crop industry, Breeding, Plan to restock, Protection of infrastructure, Sustain Quality</div> <div>Drinking water quality, protection of coastal lines&waterways</div> <div>Crisis precautions; Renewable energy; Alternative energy sources</div> </div>
Seasonal, Inter-annual (ENSO, TBO, Monsoon) 6 months – 5 yrs	Management <div> <div>Crop type&sequence Stocking rates, Herd management Change area & method, Reduce deseases, Initiate legislation</div> <div>Drinking&cooling water; Possibility of shipping</div> <div>Generation of energy; New/modify regulations</div> </div>
Sub-seasonal Intra-Seasonal MJO (30-90 days) up to 6 months	Logistics: scheduling of activties <div> <div>Planting/Harvesting Use of Pesticides/Fertiliser Choose a method, an area Prevention of Drought, Pest outbreaks</div> <div>Prevention on floods, droughts, storm surges</div> <div>Lead of adequate energy supply</div> </div>
synoptic	<div> <div>Agriculture</div> <div>Water</div> <div>Energy</div> </div>

Evaluation of Observing Systems



Global Survey of Early Warning Systems

An assessment of capacities, gaps and opportunities towards building a comprehensive global early warning system for all natural hazards

Final Version
A report prepared at the request of
the Secretary-General of the United Nations

Section on 2.1.2 Major Gaps in Risk Knowledge

Data gaps

“

Although significant progress has been made in some countries and **long historical records do exist in many cases, particularly for hazards, in others data is scarce and there are significant variations in data quality. Inconsistencies in the historical records across national boundaries and over time are common. In many cases data is accessible in nondigital paper form only.**

At the national level, the main challenges include:

- **Establishing and maintaining observing systems** and data management systems;
- **Maintaining archives, including quality control and digitisation of historical data;**
- Obtaining systematic social and environmental data for vulnerability analysis;
- Securing institutional mandates for collection and analysis of vulnerability data.

.....”

(Global Survey of Early Warning Systems, p.9)

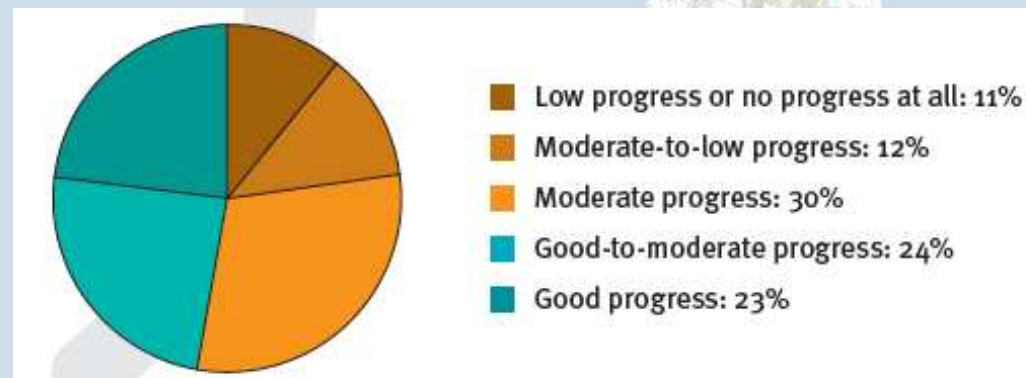


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Evaluation of Observing Systems

GCOS Progress Report 2004–2008 – Summary

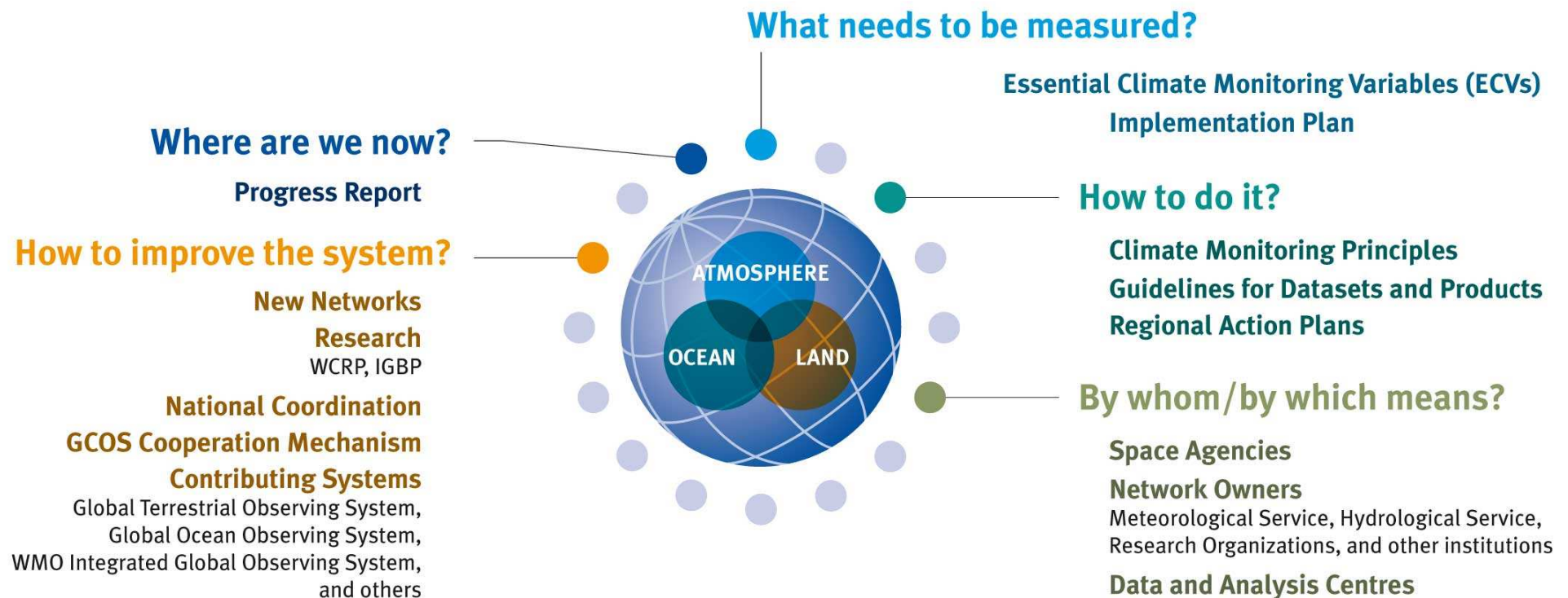
- **Developed Countries:**
 - improved climate observation capabilities,
 - limited progress in resolving financial issues related to long-term continuity
- **Developing Countries:**
 - limited (in-situ) progress, with decline in some regions,
 - capacity building support remains small in relation to needs
- **Satellite agencies:**
 - improved mission continuity and capability
 - increasingly meeting climate needs
- **Progress made, but:**
 - Many gaps persist,
 - Continued engagement needed for coordinated implementation and long-term continuity



Summary of progress on all 131
Actions in 2004 GCOS IP

Continuous Improvement and Assessment Cycle

GCOS – an all domain system



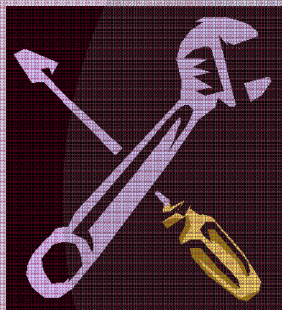
End-to-End

Supporting activities:

Maintain Infrastructure
Build on Capacities
Improve Training & Education
Mobilize Resources

Objective:

To make information available



Projects
Initiatives
Programmes

Supporting activities:

Risk Management

Assess Vulnerability & Impact
Give knowledge support to policy makers
Strengthen Communication & Outreach
Raise Awareness

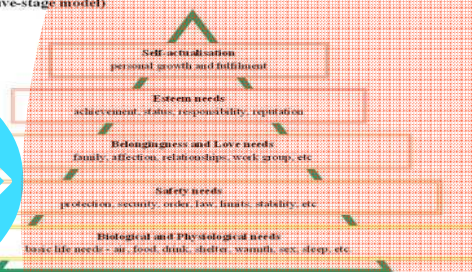
Human Health	Soil	Infrastructure, Transport, Urban Settlements, Building
Fisheries	Forestry	Tourism industry
Trade industry	Financial services industry	Biological Diversity, Ecosystems
Agriculture and Farming	Water regime, coastal and marine protection	Energy industry

Socio-economic Benefit Areas

Objective:

To offer advocacy to make informed decision-making possible

Maslow's Hierarchy of Needs
(original five-stage model)



Responsibilities

GCOS
operating area

WMO/UNEP/
UNESCO/FAO/WHO...
operating area

UN/Ministerial level
operating area

Top-Government
operating area

Key Questions

- What kind of decisions need to be made in particular sectors if they are based on specific time scales?
- What kind of actions are required if you are looking at particular time scales?
- Which kind of data are needed to make (climate) information available and to support the decision-making process for sectors important to maintain the basic life needs, safety and psychological needs ?