Application of Climate Services for health & water sector

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PRESENTATION LAY OUT

- Climate Service & it's objectives
- A brief about GFCS
- Application of Climate Services for Health sector
- Application of Climate Services for water sector

CLIMATE SERVICE & IT'S OBJECTIVES

- ✓ Climate services (CS) may be defined as the dissemination of scientifically based information and products to the public or a specific user, that enhance users' knowledge and understanding about the impacts of climate on their decisions and actions
- ✓ Efficient Climate service requires strong partnerships among providers and stakeholders, for the purpose of interpreting and applying climate information for decision making, sustainable development, and improving climate information products, predictions, and outlooks.
- ✓ Climate services intend to facilitate the use of relevant climate information across different sectors, to manage risk and adapt accordingly to future climates.
- ✓ By evaluating the different user needs and providing access to useful and clear climate information, climate services can facilitate timely, actionable and decision relevant outcomes to ensure the continued growth of key sectors at both local and global scales.

A BRIEF ABOUT GFCS

Why GFCS?

What is GFCS?

- GFCS implementation
- GFCS pillars
- GFCS Objectives
- Major areas of GFCS

WHY GFCS?

- ✓ **Many countries lack the infrastructural, technical, human and institutional capacities to provide high quality climate services.**
- ✓ **Climate services do not get to the "last mile" to those who need them the most.**
- ✓ **So there is a need for a co-ordinated and integrated approach to further reinforce the capacities of the developing world, especially LDCs & to expand multidisciplinary partnerships**
- ✓ **In response to above need, decision to establish a Global Framework for Climate Services (GFCS) came out, as a major out comes from the World Climate Conference-3 in August 2009, to strengthen production, availability, delivery and application of science-based climate prediction and services worldwide.**

WHAT IS GFCS?-GFCS IMPLEMENTATION

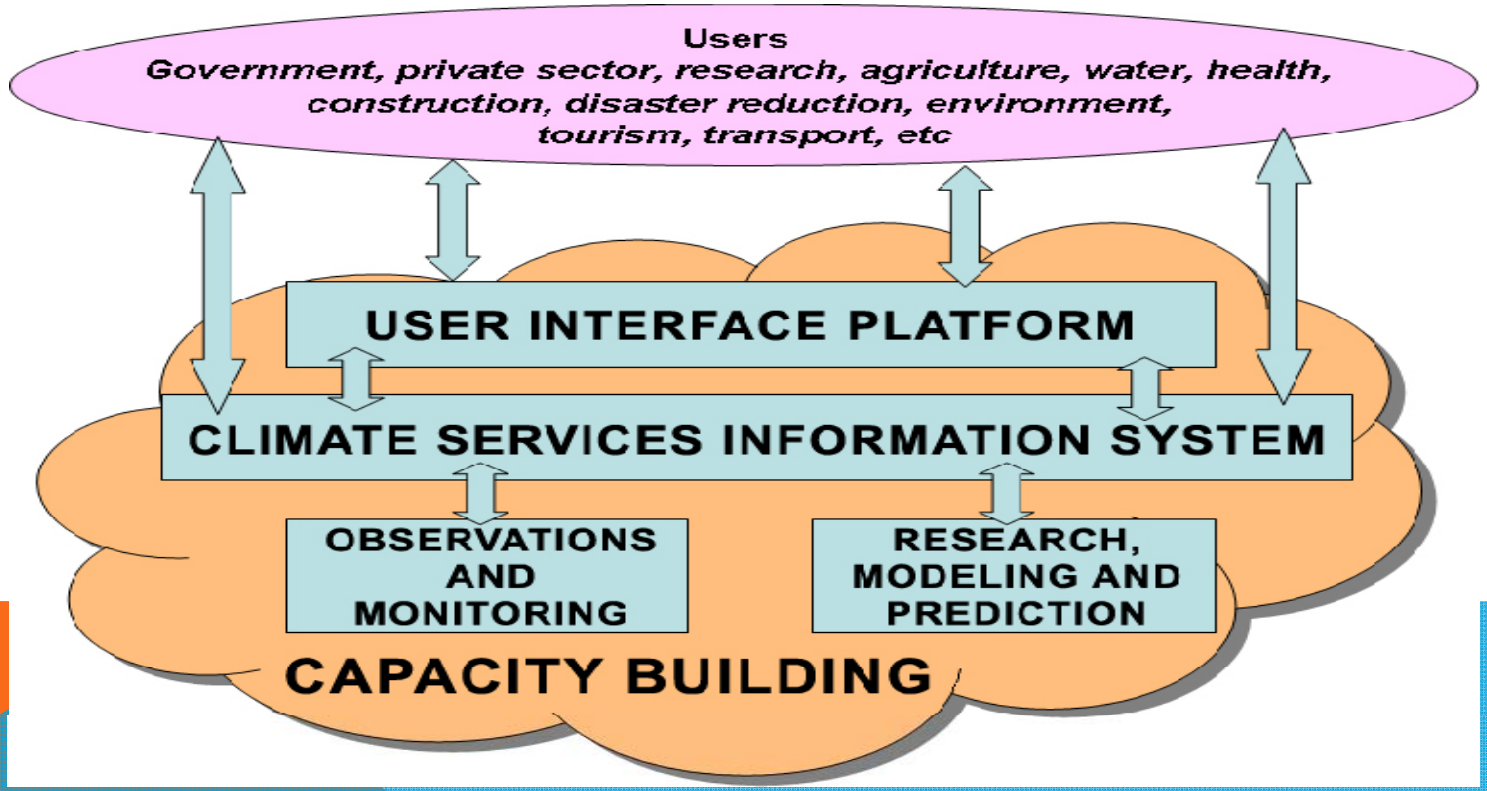
8 implementation principles:

- ✓ **Prioritize capacity building for developing countries**
- ✓ **Greater availability of climate services for all countries, in particular LDCs**
- ✓ **3 geographic domains: global, regional and national**
- ✓ **A core GFCS element: operational climate services**
- ✓ **Governments to have a central role in GFCS management, but each country will decide just how**
- ✓ **Free and open exchange of observational data, while respecting national and international data policies**
- ✓ **To facilitate and to strengthen, but not to duplicate**
- ✓ **Based on user – provider partnerships which will include all major stakeholders**

WHAT IS GFCS? GFCS IMPLEMENTATION GOALS

- ✓ **A global system to routinely generate and exchange climate data and data products**
- ✓ **Upgrade the climate service capacities in low-capacity countries to a baseline level**
- ✓ **A governance mechanism**

WHAT IS GFCS?-PILLARS OF GFCS

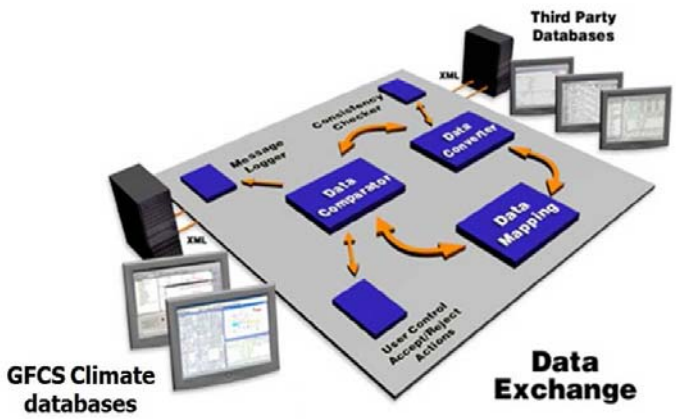


WHAT IS GFCS? PILLARS OF GFCS-USERS INTERFACE

- Provide forum for dialogue to understand needs of users and capabilities of providers
- Identify products and services requirements of users
- Allow users to provide feedback
- Increase the literacy of climate service users
- Monitor user satisfaction with the overall performance of the Framework

WHAT IS GFCS? PILLARS OF GFCS-CLIMATE SERVICE INFORMATION SYSTEM

Generate, protect and distribute climate data and information according to the needs of users and to agreed standards from the global to national levels



WHAT IS GFCS? PILLARS OF GFCS-OBSERVATIONS & MONITORING

- Collect data to meet service provision needs as identified by the User Interface Platform (UIP) and research needs
- Develop agreements and standards for generating necessary data for climate services

WHAT IS GFCS? PILLARS OF GFCS-RESEARCH, MODELING & PREDICTION

Further understanding of the climate system dynamics and change.

Engage in multidisciplinary research focusing on human vulnerabilities to changes, socio-economic impacts and adaptation options.

Engage in research to respond to needs emanating from UIP.

Translate scientific advances into applications and tools to address user needs.

WHAT IS GFCS? PILLARS OF GFCS-CAPACITY BUILDING

- Capacity building is an all encompassing mechanism that will have to be implemented in all of the four remaining pillars of the FRAMEWORK.
- Support the systematic development of the institutions, infrastructure and human resources needed for effective climate services

What is GFCS?-priority areas

Water

Disaster risk reduction

Health

Agriculture/food security

Energy

WHAT IS GFCS?-SHORT TERM PRIORITY AREAS: HEALTH

- Climate variability and climate change have important repercussions on public health.
- Temperature and rainfall conditions influence the spread of communicable diseases while extreme weather events cause injury and death.
- Demand driven climate services can empower the health community to save lives.

WHAT IS GFCS?-SHORT TERM PRIORITY AREAS: WATER

Water is vital for life, but an over or under supply can threaten life, societies and economies.

The amount and availability of water is strongly influenced by climate variability and change.

Seasonal climate outlooks and other climate services and products can greatly improve water supply management.

APPLICATION OF CLIMATE SERVICES FOR HEALTH SECTOR

- Why health sector need climate service?
- Different possible Climate Services for health.
- Different kinds of climate information useful for health sectors
- Possible benefits from Climate information for health
- WMO/WHO guide lines about approach towards Climate services for health
- Examples of success stories about Climate services for health at different parts of the world.
- Climate services for health in India

EFFECTS OF WEATHER AND CLIMATE ON VIRAL TRANSMISSION

- There are three primary modes of viral transmission : droplet, contact, and airborne (Brankston et al. 2007).
- The dominant mode of transmission likely varies according to environmental conditions (Hall 2007).
- The ambient humidity is important in the transmission of influenza because it can affect the size of the respiratory particle (Weber and Stilianakis 2008).
- When the air is dry, large drops partially evaporate, creating smaller, lighter drops that are more likely to remain airborne for extended periods of time.
- Based on studies of aerosol dynamics, a typical respiratory particle exposed to an ambient relative humidity of 80% can remain airborne for up to 1 h. When the relative humidity is decreased to 20%, the same particle is able to remain airborne for more than 24 h (Weber and Stilianakis 2008).
- When considering the combined effects of ambient humidity and temperature on influenza transmission, it appears as though airborne transmission is more sensitive to changes in these variables than contact and droplet modes.
- As temperature and humidity fluctuate with the seasons in temperate climates, and as influenza epidemics exhibit a distinct seasonality in these areas, it is believed that the airborne route is the dominant mode of transmission in temperate regions (Lowen et al. 2008).

EFFECTS OF WEATHER AND CLIMATE ON VIRULENCE

There is evidence that the degree of infectivity of a circulating viral strain may be controlled at least partially by environmental factors.

Recent work suggests that the survival of a virus is determined primarily by the characteristics of its outer casing, or envelope, which is composed of lipid compounds.

Polozov et al. (2008) suggest that the lipid envelope encasing the virus remains intact longer when the air is sufficiently cold and dry.

As the aerosolized viral particle enters the upper respiratory tract, the envelope melts, exposing the virus to healthy host cells. In addition, air pollution can have adverse effects on the RNA sequence of the virus.

Weber and Stilianakis (2008) discuss this option, along with other forms of potential environmental inactivation of influenza virus.

EFFECTS OF WEATHER AND CLIMATE ON HOST SUSCEPTIBILITY

(Eccles 2002), proposed that on a physiologic scale, the breathing of cold, dry air can slow mucociliary clearance of the nasal passage. Under normal conditions, the cilia in the nasal passage act to filter out pathogens and other aerosols from the upper respiratory tract. Exposure to cold air dramatically reduces mucus velocity (Baetjer 1967). This hypothesis has been used as a mechanism to explain the often observed rise in acute upper respiratory infections following a cold-air outbreak (Assaad and Reid 1971; Eccles 2002).

According to Edgar Hope-Simpson (1992), the seasonal, epidemic influenza virus will tend to propagate through the environment via a series of transmissions from a small number of highly infectious but generally symptomless hosts who briefly become contagious as a result of a 'seasonal stimulus'. The seasonal stimulus is identified as a deficiency in vitamin D levels because of seasonal reductions in exposure to ultra-violet (UV) radiation. Low levels of vitamin D have been shown to impair the body's antimicrobial peptide system, which is responsible for regulating the immune response (Cannell et al. 2006, 2008).

A more recent study by Johnson and Eccles (2005) found that chilling of the feet in cold water leads to vasco constriction of the upper respiratory system, which may increase susceptibility if exposed to viral particles.

The abrupt rise in clinical infections typically associated with large-scale influenza outbreaks during the winter season may be at least partially related to the increased efficiency and duration of viral transmitters when the air is cold.

WHY DOES THE HEALTH COMMUNITY NEED CLIMATE SERVICES?

- HEALTH PROFESSIONALS ARE INCREASINGLY CONCERNED ABOUT HOW CHANGING PATTERNS OF CLIMATE VARIABILITY AND LONG-TERM CLIMATE CHANGE ARE MEDIATING HEALTH RISKS AND AFFECTING ABILITY OF HEALTH PROFESSIONALS TO PROTECT THE HEALTH OF CITIZENS.
- AT ONE END OF A SPECTRUM, EXTREME WEATHER EVENTS CAN SERIOUSLY AFFECT PEOPLE'S MENTAL AND PHYSICAL HEALTH AND CAN COMPROMISE THEIR ACCESS TO HEALTH CARE, FOOD, CLEAN WATER AND PHYSICAL SAFETY, RESULTING IN VULNERABILITY, ILLNESS, INJURY OR DEATH.
- AND AT THE OPPOSITE END, EVEN SMALL OR GRADUAL CHANGES IN WEATHER AND CLIMATIC CONDITIONS – SUCH AS LOCAL TEMPERATURE, HUMIDITY OR WIND DIRECTION – CAN RESULT IN SIGNIFICANT SHIFTS IN PEOPLE'S EXPOSURE TO HARMFUL OR BENEFICIAL CONDITIONS, FROM DISEASE TRANSMISSION TO CHANGING WATER QUALITY.

Different possible Climate Services for health.

To monitor how and where smoke plumes move during forest fires to anticipate when and where populations may be in harm's way.

To indicate when and where populations may be at risk for seasonal disease exposure and better target vector control interventions.

To provide customized information for high-risk populations during heat waves.

To understand drought risks and reduce vulnerabilities to rapid and slow onset impacts of droughts.

Identification of climate influences on disease dynamics;

Mapping disease transmission risks at high spatial resolution to indicate when and where populations may be at risk for seasonal disease exposure;

Production and supply of customized information for high-risk populations during heat waves;

To understand risks of urban flooding and mitigate vulnerabilities to it.

DIFFERENT KINDS OF CLIMATE INFORMATION USEFUL FOR HEALTH SECTORS

Timescale	Examples of climate information products – which may be available and relevant in some regions and seasons.	Example health-decision applications.
HISTORIC RECORD OF CLIMATE OBSERVATIONS	Historic time series data, summary statistics and other information products	Epidemiological trend and regression analysis to understand associations of climate and health; develop disease forecasting from current and recent observation data, particularly for infectious diseases with time lags between observed ambient conditions and diseases onset.
SHORT-TERM CLIMATE INFORMATION (1 – 12 MONTHS)	Risk indices for extreme temperature, Long-range forecasts of average, maximum and minimum Temperature and precipitation conditions 1 - 9 months ahead. Tercile forecasts probabilistic prediction of rainfall and temperature.	Short-term operational investment in preparedness, outbreak prevention, resource needs.
MID-TERM CLIMATE INFORMATION (ANNUAL TO MULTI-YEAR)	Annual to interannual forecasts describing large scale state of the climate, Status of El Niño Southern Oscillation (ENSO) Conditions, outlook from Dynamic and statistical climate models	1-5 year policy decisions for disease control, research, health systems planning.
LONG-RANGE CLIMATE INFORMATION (DECADES)	10-30 year decadal forecasts of surface temperature, precipitation, sea surface temperatures, Climate change scenarios.	Long-term health infrastructure investments, research, demographic and population models, health system planning Increase understanding of disease trends, epidemic behaviour on a regional scale.

Possible benefits from Climate information services for health

Risk and vulnerability identification;

Disease control strategies;

Health policy and regulations;

Disease monitoring and surveillance;

Financial and human resource allocation;

Pharmaceutical, health supply, pesticide and vaccine supply flow;

Health infrastructure sitting and maintenance;

Emergency preparedness;

Community education and public health information dissemination,

Targeted public advisories, medicines or supplies for vulnerable populations;

Training of the health workforce for potential outbreaks or signs of illness

(Even including side-effects of medicines in extreme temperatures);

Impact assessment of climate sensitive interventions.

A HOLISTIC APPROACH OF DEVELOPING CLIMATE SERVICES FOR HEALTH: WMO/WHO GUIDELINES

- SIX COMMON COMPONENTS COMPRISING THE APPROACHES TAKEN TO DEVELOP AND DELIVER CLIMATE PRODUCTS AND SERVICES FOR HEALTH.

THESE INCLUDE ACTIVITIES

- TO CREATE AN ENABLING ENVIRONMENT,
- TO BUILD CAPACITY,
- TO CONDUCT RESEARCH,
- TO DEVELOP AND DELIVER PRODUCTS AND SERVICES,
- TO APPLY THE KNOWLEDGE, AND
- TO EVALUATE THE PRODUCTS AND USER EXPERIENCE.

Components	A few Common approaches	Personnel involved
ENABLING ENVIRONMENT	Organising regular meetings, trainings, and workshops with all stakeholders, MoU with partners, etc.	Health, Climate, Health determining sectors, I&CT personnel, policy-makers, legal experts, statisticians and community representatives.
Capacity building	Training on the health risks exacerbated by climate and weather conditions, Conducting workshops, Design & conduction of tailored training and outreach program, etc.	Health, Climate, Multi disciplinary health relevant partners, Citizens.
RESEARCH	Climate and health relation study, Development of tools for visualization and communication of information, Cost-efficiency assessments, etc.	Health, Climate, academicians, researchers etc.
PRODUCT AND SERVICE	Applications of climate outlooks and forecasts. climate indicators and thresholds, Early warning systems etc.	Health, Climate, Civic bodies, Public health, NGOs etc.
APPLICATION	Holding Workshops with national health authorities, Pilot testing the service prior to extensive implementation etc.	Health, Climate, Civic bodies, Public health, academicians, researchers NGOs etc.
EVALUATION	Test the user friendliness of CS, lives saved, cost effectiveness etc., increased capacity etc.	All stake holders

EXAMPLES OF SUCCESS STORIES ABOUT CLIMATE SERVICES FOR HEALTH AT DIFFERENT PARTS OF THE WORLD

Case-1: A Ecuador–Peru cooperation to use climate and health information for dengue surveillance: establishing a multinational and multi-disciplinary team

Case-2: Integrating air quality, health and meteorological expertise to address the impact of poor air quality on health in India.

Case-3: Long-term climate and health collaboration in Ethiopia to improve forecasting of malaria outbreaks.

Case-4: In Madagascar Climate and Health Working group: information sharing policies, clear needs identification, and joint trainings.

EXAMPLES OF SUCCESS STORIES ABOUT CLIMATE SERVICES FOR HEALTH AT DIFFERENT PARTS OF THE WORLD

Research categories	Case studies
Applied	A. Vulnerability and adaptation assessment: Identifying climate information and decision needs in Bhutan. B. Understanding the sensitivity of dengue to climate and urban risk factors in Minas Gerais State, Brazil. C. Analysis of the health impacts of climate variability in four major South American cities.
Product	D. Malaria sensitivity to climate in Colombia: the importance of data availability, quality and format. E. Iterative development and testing of a heat warning and information system in Alberta, Canada. F. Predicting the impacts of climate on dengue in Brazil: Integrated risk modelling and mapping.
Operation	G. Tested a methodology for evaluating the best ways to communicate climate knowledge in Austria. H. Knowing when cold winters and warm summers can reduce ambulatory care performance in London.

EXAMPLES OF SUCCESS STORIES ABOUT CLIMATE SERVICES FOR HEALTH AT DIFFERENT PARTS OF THE WORLD

Categories	Case studies
Data collection and management	A. Translating climate model outputs for public health practice in USA. B. Innovative community based data collection to understand and find solutions to rainfall-related diarrhoeal diseases in Ecuador.
Integrated disease surveillance systems	C. EPIDEMIA: Integrating climate information and disease surveillance for malaria epidemic forecasting in Ethiopia. D. The Brazilian Observatory of Climate and Health: Experience of organizing and disseminating climate and health information in Manaus, Amazon region
Indicators	E. Climate-specific pollen indicators and population exposure monitoring tools to better manage the allergy season in Hungary.
Risk mapping and risk monitoring	F. Mapping and modelling plague in Uganda to improve health outcomes.
Health risk forecasts	G. Forecasting malaria transmission: finding the basis for making district scale predictions in Uganda.
Early warning systems	H. Heat wave and health risk early warning systems in China.
Projections and scenarios	I. HEALTHY FUTURES Atlas: A publicly available resource for evaluating climate change risks on water-related and vector-borne disease in eastern Africa

EXAMPLES OF SUCCESS STORIES ABOUT CLIMATE SERVICES FOR HEALTH AT DIFFERENT PARTS OF THE WORLD

A. Innovative heat wave early warning system and action plan in Ahmadabad, India.

B. Managing the health impacts of drought in Brazil: A comprehensive risk reduction framework.

C. Early warning systems to guide infectious diseases control in Europe.

D. Improving malaria evaluation and planning with enhanced climate services in East Africa.

E. Using climate information to predict and control meningitis epidemics in West Africa.

F. Using climate knowledge to guide dengue prevention and risk communication ahead of Brazil's 2014 FIFA World Cup

CLIMATE SERVICES IN IMD: CURRENT STATUS

IMD is the nodal Government agency responsible for providing operational weather and climate services required for the country.

IMD provides Climate Services by carrying out climate related activities, like Climate Monitoring and Analysis, Climate Prediction (Seasonal Forecasts), Climate Data Management, Climate Research and Climate Applications.

Presently IMD, in a formal way, providing Climate services to Agriculture and Disasters management sectors

Towards climate service for health sectors, already MoU has been signed between IMD and state health departments of Gujarat and Maharashtra. This has resulted implementation of a heat action plan at Nagpur, Ahmadabad etc.

OBJECTIVES OF IMD'S CLIMATE SERVICES FOR HEALTH

- TO GENERATE DIFFERENT CLIMATE INDICES FOR HEALTH, AT DIFFERENT STATION OR GRID POINTS FOR DIFFERENT MONTHS/SEASONS USING AVAILABLE HISTORICAL CLIMATE DATA.
- TO PREPARE CLIMATOLOGY OF DIFFERENT CLIMATE-HEALTH INDICES FOR DIFFERENT MONTHS/SEASONS.
- TO COLLECT DISEASE EPIDEMIOLOGICAL DATA FROM HEALTH DEPARTMENTS OF DIFFERENT STATES/CIVIC BODIES THROUGH RESPECTIVE RMCS/MCS.
- TO PRODUCE WEEKLY, FORTNIGHTLY, MONTHLY, SEASONAL AND DECADAL OUTLOOK OF TMAX,TMIN, RAINFALL, WIND AND HEALTH INDICES.
- TO TAKE UP JOINT STUDIES WITH OTHER INSTITUTES FOR UNDERSTANDING CLIMATE DISEASE RELATIONSHIP USING DISEASE DATA AND ABOVE MENTIONED INDICES FOR ADVISORY SERVICES.
- TO DEVELOP DISEASE TRANSMISSION MODEL USING CLIMATE DATA AND DISEASE DATA, IN COLLABORATION WITH OTHER RESEARCH INSTITUTES.
- TO STUDY IMPACTS OF THE CLIMATE SERVICES PROVIDED TO HEALTH SECTOR.

IMPACT BASED FORECASTS AS PER THRESHOLDS PROVIDED BY THE USERS

10 CITIES IN 2016

	≤ 41 deg. Selsius
	41.1 to 43 Celcius
	43.1 to 44.9 Celcius
	> or eq. 45 deg Celcius

DATE	FC	Forecast in colour code COLOUR CODE	May-16 ACT	ACTUAL in COLOUR CODE
01	42		43.1	
02	41		43.3	
03	42		42.1	
04	42		42.5	
05	40		39.6	
06	41		40.0	
07	41		39.9	
08	41		40.6	
09	43		42.4	
10	43		42.7	
11	42		43.0	
12	44		43.5	
13	44		44.0	
14	44		44.6	
15	44		44.0	
16	44		44.3	
17	45		43.5	
18	46		45.0	
19	47		46.9	
20	46		48.0	
21	43		44.6	
22	43		44.0	
23	43		42.6	
24	42		43.0	
25	41		41.9	
26	42		41.5	
27	41		41.4	
28	42		41.5	
29	41		40.8	
30	41		41.3	
31	41		41.5	

HEAT RELATED CLIMATE SERVICES FOR HEALTH

- INNOVATIVE HEAT WAVE EARLY WARNING SYSTEM AND ACTION PLAN IN AHMEDABAD, INDIA.

IN APRIL 2013, THE AMC AND PARTNERS LAUNCHED THE CITY'S INITIAL HEAT ACTION PLAN.

THE AMC DESIGNATED ITS HEALTH DEPARTMENT AND A DEPUTY HEALTH OFFICER AS LEAD AGENCY AND LEAD OFFICER, RESPECTIVELY, WITH THE OVERARCHING RESPONSIBILITY TO COORDINATE ALL RELATED MUNICIPAL ACTIVITIES.

THE LEAD OFFICER MONITORS DAILY TEMPERATURE FORECASTS, SENDS HEAT ALERTS AND DISSEMINATES PUBLIC HEALTH MESSAGES TO LOCAL GOVERNMENT DEPARTMENTS, HEALTH SERVICES AND THE MEDIA.

- IMD GFS (T1534) MODEL OUT PUT PRODUCTS FOR HEAT WAVE

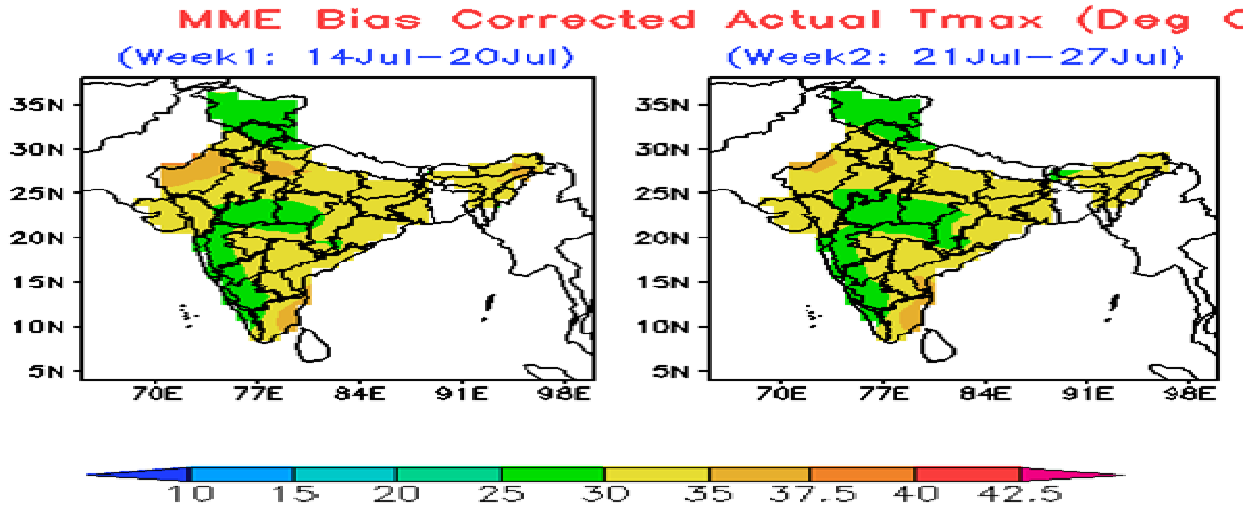
Based on direct model output daily Tmax, HI max charts are prepared and kept in IMD website.

Bias corrected Tmax, Tmax anomaly charts are prepared.

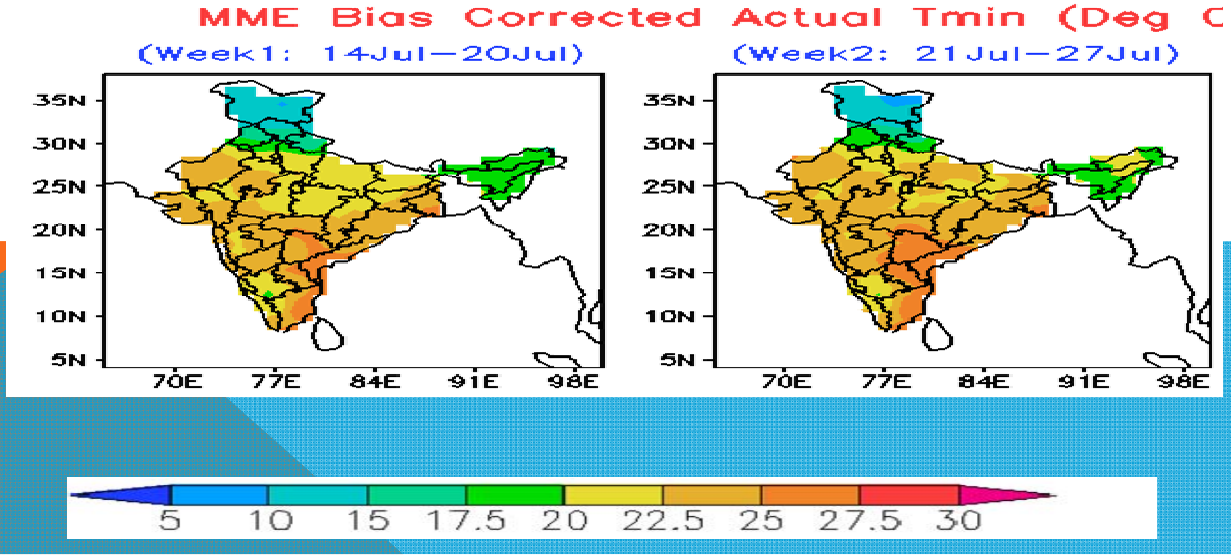
From this year a new initiative has been taken by which whenever in summer, Tmax exceeds certain threshold, it is immediately been informed to entire medical fraternity, via the Indian Medical Association.

- As a Climate Service for Health, IMD has recently initiated (on experimental basis) preparation of climate information for health, for Vector borne diseases (VBD) like Dengue and Malaria for the country.
- For that products of Extended Range Forecasting System are used.
- Through this initiative, regions over which conducive climatic conditions for VBD/WBD are likely to prevail during succeeding two weeks are indicated.
- Presently only temperature is used, because bias corrected maximum/minimum temp forecast is available.
- Humidity, right now is not being considered, as bias corrected humidity forecast is yet to be available.

Predicted Maximum Temperature



Predicted MinimumTemperature



week	VBD	Threshold minimum temp (Th-Tmin)	Region (s) with Predicted Tmin within range of Th-Tmin	Threshold maximum temp (Th-Tmax)	Region(s) with Predicted Tmax within range of Th-Tmax
14th July to 20th July	Malaria Plasmodium Falciparum	16-19 ^{0}C	Punjab, Uttarakhand, North East states, some part of Haryana,	33-39^{0}C	All States except Jammu & Kashmir, Himachal Pradesh, Konkan & Goa, Coastal Karnataka, South Interior Karnataka, major part of Uttarakhand, Madhya Pradesh, Madhya Maharashtra, Vidarbha, Kerala, some part of North Interior Karnataka, Tamil Nadu & Odisha
	Malaria Plasmodium vivax	14-15 ^{0}C	Jammu & Kashmir, Himachal Pradesh		
21st July to 27th July	Malaria Plasmodium falciparum	16-19 ^{0}C	Punjab, Uttarakhand, major part of North East states	33-39^{0}C	All States except Jammu & Kashmir, Himachal Pradesh, major part of Uttarakhand, Madhya Pradesh, Chhattisgarh, Vidarbha, Madhya Maharashtra, South Interior Karnataka, Coastal Karnataka, Konkan & Goa, some parts Telangana, Kerala, North Interior Karnataka, East Rajasthan, sub Himalayan Bengal & Sikkim.
	Malaria Plasmodium vivax	14-15 ^{0}C	Jammu & Kashmir, Himachal Pradesh		

PROPOSED FUTURE INITIATIVES

- TO CARRY OUT RESEARCH WORK, IN COLLABORATION WITH OTHER INSTITUTES, VIZ., NVBDC, DEPTT OF PUBLIC HEALTH, TO STUDY CLIMATE DISEASE(VBD) RELATIONSHIP AND THEREBY TO FIND THRESHOLD VALUE OF CLIMATE PARAMETERS FOR ALL SMART CITIES.
- TO CARRY OUT RESEARCH WORK, IN COLLABORATION WITH OTHER INSTITUTES, VIZ., DEPTT OF PUBLIC HEALTH, TO FIND THRESHOLD VALUE OF CLIMATE PARAMETERS FOR HEAT/COLD RELATED MORBIDITY/MORTALITY FOR ALL SMART CITIES.
- ONCE THE THRESHOLD VALUES COME OUT AND BIAS CORRECTED HUMIDITY FORECAST IS AVAILABLE, THEN PROBABILISTIC OUTLOOK ABOUT THE REGION WITH CONDUCIVE CLIMATIC CONDITION FOR VBD SHALL BE PREPARED.
- DEVELOPMENT OF FUZZY LOGIC BASED DISEASE TRANSMISSION MODEL FOR DIFFERENT VBD, IN LINE WITH MARA PROJECT IN AFRICA.
- DEVELOPMENT OF R0 (THE BASIC REPRODUCTION RATE) MODEL FOR DIFFERENT VBD/WBD FOR INDIAN PERSPECTIVE.

CLIMATE APPLICATION FOR WATER SECTOR

Conceptual model of the effect of greenhouse gases and global warming on the hydrological cycle and phenomena associated with climate extremes

Impacts of climate on the water sector

Why water sector needs Climate service?

Basic climatic information needs of the hydrological sector

Possible water sector adaptation to contemporary Climate variability

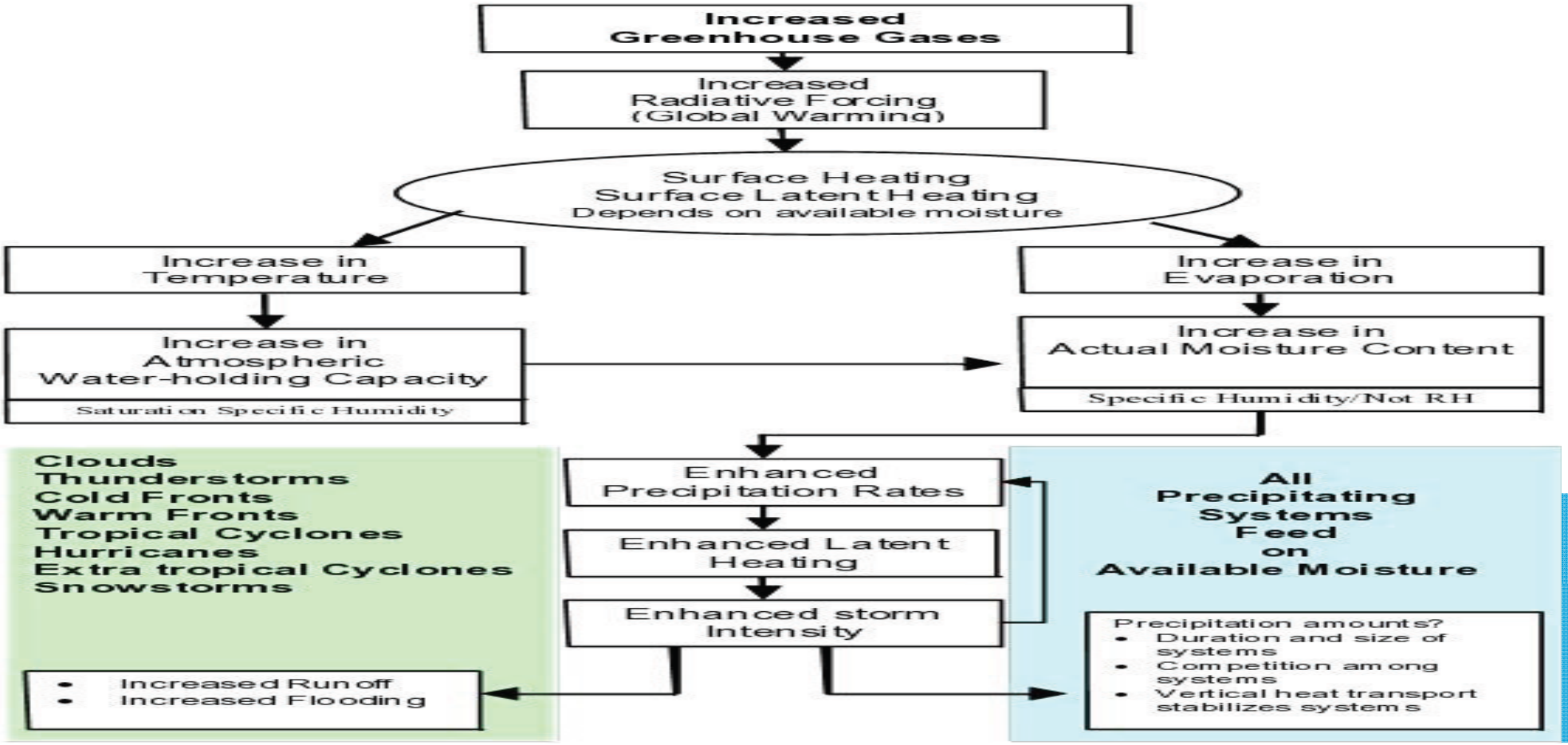
Possible climate services for water

Goals of Climate services for water sector

Climate service for water sector in IMD

Proposed future initiatives towards Climate service for water sector in IMD

CONCEPTUAL MODEL OF THE EFFECT OF GREENHOUSE GASES AND GLOBAL WARMING ON THE HYDROLOGICAL CYCLE AND PHENOMENA ASSOCIATED WITH CLIMATE EXTREMES (SOURCE: MINISTRY OF WATER RESOURCES)



IMPACTS OF CLIMATE ON THE WATER SECTOR

A decrease in rainfall results into greater decrease in river runoff/streamflow and inflows to groundwater storages.

During dry conditions greater rainfall is necessary to replace soil moisture,

Vegetation in dry times can impact on river runoff.

During dry conditions, increased evaporation during dry condition may lead to the losses from major storages and river systems.

Extreme dry climate conditions can impact on vegetation through both changes in the vegetative cover and destruction of the vegetative cover (bushfires).

Increased rainfall intensity can also lead to increases in runoff as soil moisture stores are full and a greater percentage of the rainfall runs off.

Potential climate change impacts affecting water availability include changes in precipitation amount, intensity, timing and form (rain or snow); changes in snowmelt timing and changes to evapotranspiration.

The combination of increasing rainfall extremes and degraded vegetation coverage also has the ability to increase the likelihood of flash floods and landslides. All of these can also impact on the ecological balance of the water system and thus have major implications for water quality (algal blooms, for example).

WHY WATER SECTOR NEEDS CLIMATE SERVICES?

Manifestation of Increased effect of climate variability and climate change and its impact on people, ecosystems and economies are done mainly through water sector.

As the fundamental drivers of the hydrological cycle are affected by increasing climate variability and climate change, they will have large impacts on water resources availability and demand. These changes in water availability and demand will exacerbate existing issues in sectors such as health, food production, sustainable energy and biodiversity.

Periods of prolonged, unexpected dry spells can limit the use and distribution of water. With advanced knowledge of climate variation, the water management sector could adapt accordingly to prepare for and optimise strategies adopted under unfavourable or extreme weather conditions; for example, the impact and outcomes associated with different decisions for the operation of a specific river basin on water supply, storage capacities, hydropower and agricultural irrigation under different climate scenarios.

WHY WATER SECTOR NEEDS CLIMATE SERVICES?....

Variation in precipitation and temperature and its effect on the land and atmosphere is core to the management of water resources.

Long-term decisions are required to be made today for a future climate that is relatively unknown within the water management sector. Index and threshold systems that could trigger a flood or severe drought should lead to specific disaster prevention actions.

With such information, seasonal-to-decadal climate forecast information can help decision-makers to understand the risks associated with an increasingly variable water cycle over the coming months to years to decades, so that strategies can be adapted accordingly to minimise the impact of water resources within society and industry.

Hence information about past climate, present climate, Climate change, Climate prediction/outlook and long term climate projection are very essential for the hydrological sector.

BASIC CLIMATIC INFORMATION NEEDS OF THE HYDROLOGICAL SECTOR

Field of application	*Hydrological element needed*	*Meteorological element needed*	*Type of meteorological input data*	
			Timescale	*Space Scale*
Data processing, plausibility check of hydrological data	Runoff	Precipitation	d, m	s, a
Water balance (non real-time)	Runoff	Precipitation	y, m, d	a
	Evaporation	Radiation	d, m	s, g
	Soil moisture	Sunshine duration[1]	d, m	s, g
	Groundwater	Air temperature [1]	d, m	s, g
		Air humidity [1]	d, m	s, g
		Wind speed [1]	d, m	s, g
Simulation of time series (non real-time)	Runoff	Precipitation	y, m, d	a
	Groundwater	Radiation	d, m	s, g
	Water temperature	Air temperature	h, d, m	s, g
	Dissolved matter [2]	Air humidity		
Extreme value statistics of floods and low flows (non real-time)	Runoff	Precipitation	y, m	s
	Water level		min, max	
Forecasting (real-time)	Runoff	Precipitation	h, d	s, a
	Water level			
	Snow cover		d	s, a
	Water equivalent of snow			
	Snow melt	Radiation	h, d	s
	Soil Moisture	Air temperature	h, d	s

s = point values a = areal values g = grid values
y = annual values m = monthly values d = daily values
h = hourly values min = minimum values max = maximum values

1 = meteorological elements needed for the calculation of evaporation
2 = averages of selected weather stations (dry and wet weather conditions)

POSSIBLE ADAPTATION IN WATER SECTOR TO CONTEMPORARY CLIMATE VARIABILITY

The judicious use of reservoir storage, as well as conjunctive surface water and groundwater management.

water managers need to re-evaluate the effectiveness of current demand management, in the light of the changes in demand of water in irrigation and thermal power plant.

Planning for new investments or for capacity expansion (reservoirs, irrigation systems, levees, water supply, wastewater treatment, ecosystem restoration);

Operation, monitoring and regulation of existing systems to accommodate new uses or conditions (ecology, climate change or population growth, for example);

POSSIBLE ADAPTATION IN WATER SECTOR TO CONTEMPORARY CLIMATE VARIABILITY

- Maintenance and major rehabilitation of existing systems (dams, barrages, irrigation systems, canals, pumps, wetlands, among others);
- Modifications in processes and demands (water conservation, pricing, regulation, legislation, payments for ecosystem services, consumer education and awareness) for existing systems and water users;
- Introducing new efficient technologies (desalting, biotechnology, drip irrigation, wastewater reuse, recycling, solar energy).

POSSIBLE CLIMATE SERVICES FOR HYDROLOGICAL SECTOR

Flood inundation prediction and risk assessment.

- Quantitative precipitation forecasting (QPF)
- Seasonal and long-range forecasting
- Rainfall depth-duration-frequency datasets

Hydropower

- **Short-term rainfall forecast**(2-3 days ahead) for flood protection and the security of installations.
- **Medium-range forecasts** (7-15 days ahead) for the optimisation of production.
- **Hydrological trends and outlooks under future climate conditions** for anticipating the effects of expected changes in runoff volume, extremes and seasonability, which directly affect hydropower generation.

Transport

- **Monthly to seasonal forecasts** for the medium- to long-term planning and enhancement of the water bound logistic chain.
- **Climate projections** for the optimal future fleet planning of shipping companies as well as for infrastructural waterway management.

Urban water

Weather extremes affect freshwater quality and quantity, challenging treatment capacity, safety of drinking water and reliability of supply in urban areas. So, **extreme event monitoring, prediction/outlook is a potential Climate service.**

GOALS OF CLIMATE SERVICES FOR WATER SECTOR

To create a link between experts in climate research and the water management industry to understand the demand and use of climate forecast information within the sector.

To improve and advance the techniques currently used to understand and manage climate variability and risk within the water management sector, at various timescales.

To contribute to a global framework to improve the transfer and exchange of information on climate risk management practices.

CLIMATE SERVICE FOR WATER SECTOR IN IMD

IMD is the nodal Government agency responsible for providing operational weather and climate services required for the country.

Weather & climate services for Water sector are done by New Delhi & Pune office of IMD.

New Delhi office provides following services:

- Rainfall Monitoring
- Hydromet Forecasting (QPF)
- Hydromet Design
- National and International Co-operation and Public Awareness.

Main Activities:

- Real Time Monitoring of Rainfall and preparation of rainfall summary
- Meteorological support for flood warning and flood control operations to field units of Central Water Commission (CWC) through its Flood Meteorological Offices (FMOs).
- Hydro-meteorological analysis of different river catchments for project authorities.
- Compilation of rainfall statistics

Details can be found in the webpage

http://www.imd.gov.in/pages/services_hydromet.php

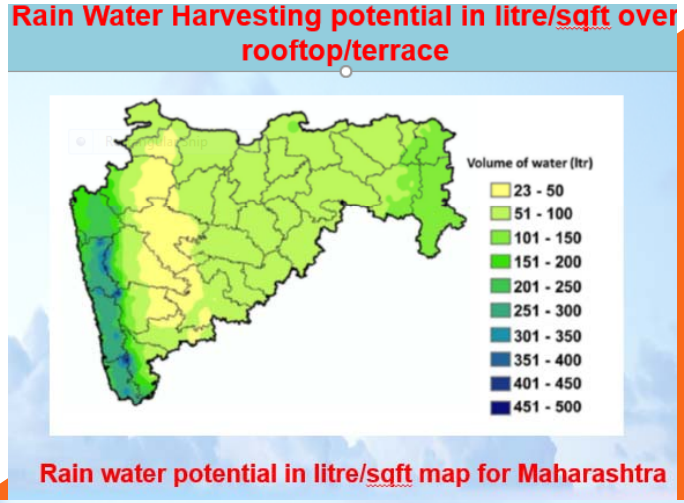
CLIMATE SERVICE FOR WATER SECTOR IN IMD

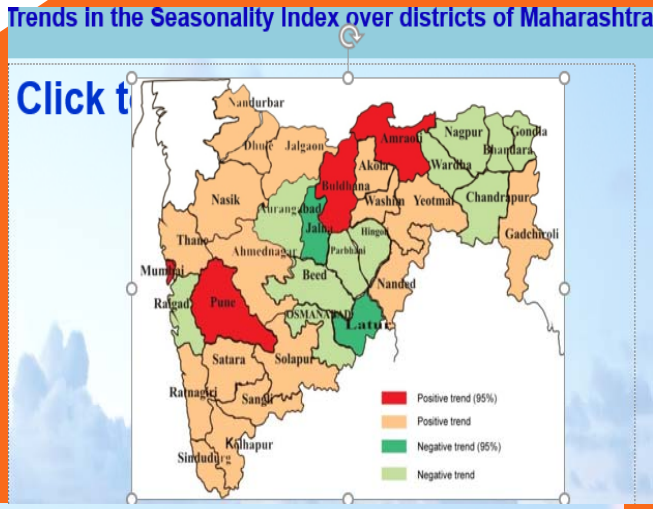
- **IMD's o/o CR & S, Pune provides following services:**
  - Long range seasonal prediction of rainfall for the country as a whole & for all homogeneous regions during SWMS and that for southern met subdivisions, viz., Kerala, TN, NCAP, Rayalaseema, SIKKA during NEMS.
  - Extended range forecast of rainfall valid for next four weeks, with weakly updating, for entire country.
  - Issuing monthly outlook of rainfall using CFSv2 model, on experimental basis.
  - Preparation of rainfall climatology for the country as a whole, state wise, subdivision wise, district wise and also river basin wise with periodical updating.

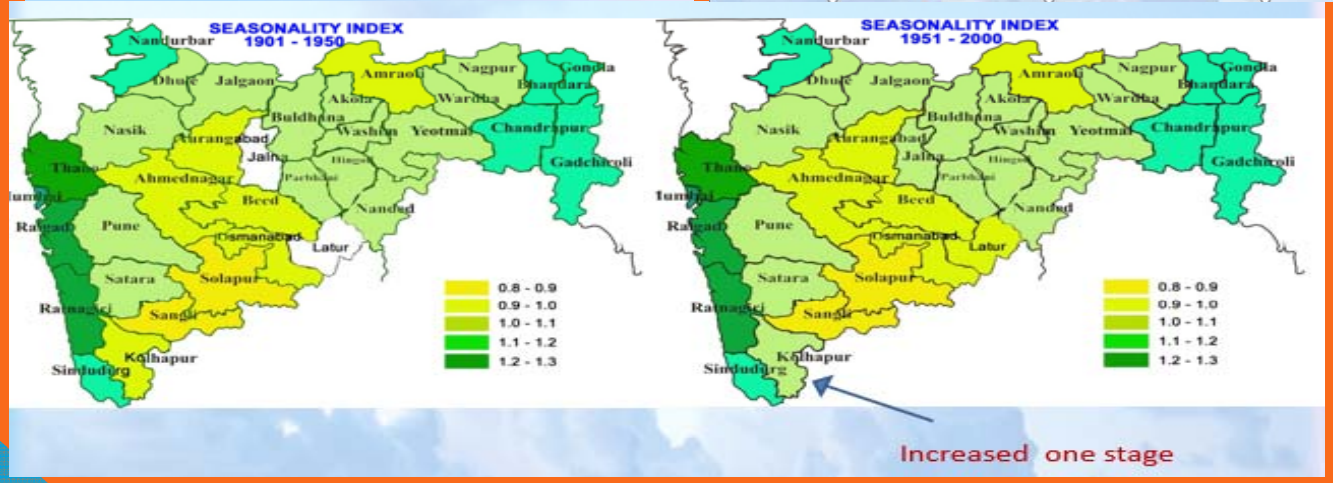
  Preparation of monthly climate diagnostic bulletin.

CLIMATE SERVICE FOR WATER SECTOR IN IMD

- COMPREHENSIVE RESEARCH TO IDENTIFY (LONG TERM, DECADAL ETC.) OBSERVED CLIMATE VARIABILITY, CLIMATE CHANGE AT DIFFERENT SPATIAL SCALE.
- PREPARATION OF GRID POINT RAINFALL DATA, USING OBSERVED STATION LEVEL DATA.
- DROUGHT MONITORING AND OUT LOOK WITH THE HELP OF SPI OUT LOOK (PREPARED BASED ON ERP OF RAINFALL).
- RETURN PERIOD ANALYSIS OF RAIN STORMS.
- STATE WISE RAINWATER HARVESTING POTENTIAL MAPS







PROPOSED FUTURE INITIATIVES

Climatology (daily/weekly/monthly/seasonal/annual) of total volume of water over a river catchment equivalent to rainfall received over that, based on IMD's gridded daily rainfall data.

Forecast/Outlook about anomaly of the total volume of water over a river catchment equivalent to rainfall received over that at different ranges, viz., weekly/monthly/seasonal, based on ERP/seasonal prediction of rainfall.

These graphical products will enable government agencies, private institutions, and individuals to make informed decisions about risk-based policies and actions to mitigate the dangers of floods.

the probability of a river exceeding minor, moderate, or major flooding,

the chance of a river exceeding a certain critical level and volume at specific points on the river during a fortnight/month/season.

PROPOSED FUTURE INITIATIVES....

a map of areas surrounding the forecast point provides information about major roads, railways, landmarks, etc., likely to be flooded, the levels of past floods, etc.

In additional, the website will provide maps of the river basin and various points along the rivers for which water level information are available. The data will include information about floods.

These products can be used by a wide range of people, such as local govt authority, barge operators, power companies, recreational users, farmers, households, businesses, and environmentalists.

This tool will use sophisticated computer models and large amounts of data from a wide variety of sources, which include super computers, automated rain gauges, geostationary satellites, Doppler radars, weather observation stations, and the communications system. These inputs will be used to generate above mentioned hydrological forecast/outlook for selected river basins across the country.

THANKS FOR KIND PATIENCE HEARING