Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

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JAU,Junagadh

Re-Interaction Meet on
"Energy-Water-Food Nexus: Challenges Ahead"
IPCC Climate Change Report- AR6 -2022
(October 7, 2022)

Organized by

National Council for Climate Change Sustainable Development and Public Leaderships (NCCSD), Ahmedabad

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

IPCC Report AR6-2022 : Highlights

- Humans are the main drivers of climate change.
- The alarm bells: greenhouse gas emissions from fossil fuel burning and deforestation are choking our planet and putting billions of people at immediate risk.
- Methane levels : largely caused by agricultural farming, animals, oil and gas operations, and abandoned coal mines, are at their highest for 800,000 years.
- Methane has global warming impact 84 times higher over a 20-year period
- IPCC report 2022 : Indeed "It is clear that human influence has warmed the atmosphere, ocean and land".
- IPCC group concludes they have high confidence on : humans are the main drivers behind issues such as more intense heat waves, glaciers melting, and our oceans getting warmer.
- IPPC : the heat wave in Siberia in 2020 and the extreme heat seen across Asia in 2016 would likely not have happened if humans had not burned so much fossil fuel.
- According to the World Research Institute, global temperatures have risen by 1.1ºC so far, and already we are seeing an increase in natural disasters such as flooding, hurricanes, and other events.





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IPCC Report AR6-2022 : Highlights

- The scientists have been warning since many years, about the catastrophic results on the climate if the world reaches average temperatures of **1.5ºC** above pre-industrial levels
- The IPCC report 2022 warned the world : Rise of **1.5 ºC** within **next 2 decades.**
- **We are set to pass the 1.5ºC threshold by 2040.**
- Also warned that only the most drastic cuts in **carbon emissions** from now would help prevent an environmental disaster.
- Taking the **high-carbon pathway**, the worst of the scenarios, would see global temperatures rise by more than **4 ºC by the end of the century i.e in 80 years**.
- The world has not seen temperature increases of more than **2.5 ºC in** over such a **short space of time** in **more than last 3 Million years**.

IPCC Report AR6 : Major Impacts

(1) Forests could start to die:

- The moisture extraction from the tree zone will be increased to meet the increased tree evapotranspiration due to warming effects.
- This will limits the tree growth.
- Thus, as the warming continue to rise, forests could begin to die off.
- Trees play a key role in absorbing CO_2, so if deforestation occurs, and forests stop growing, it would have disastrous consequences on the environment;

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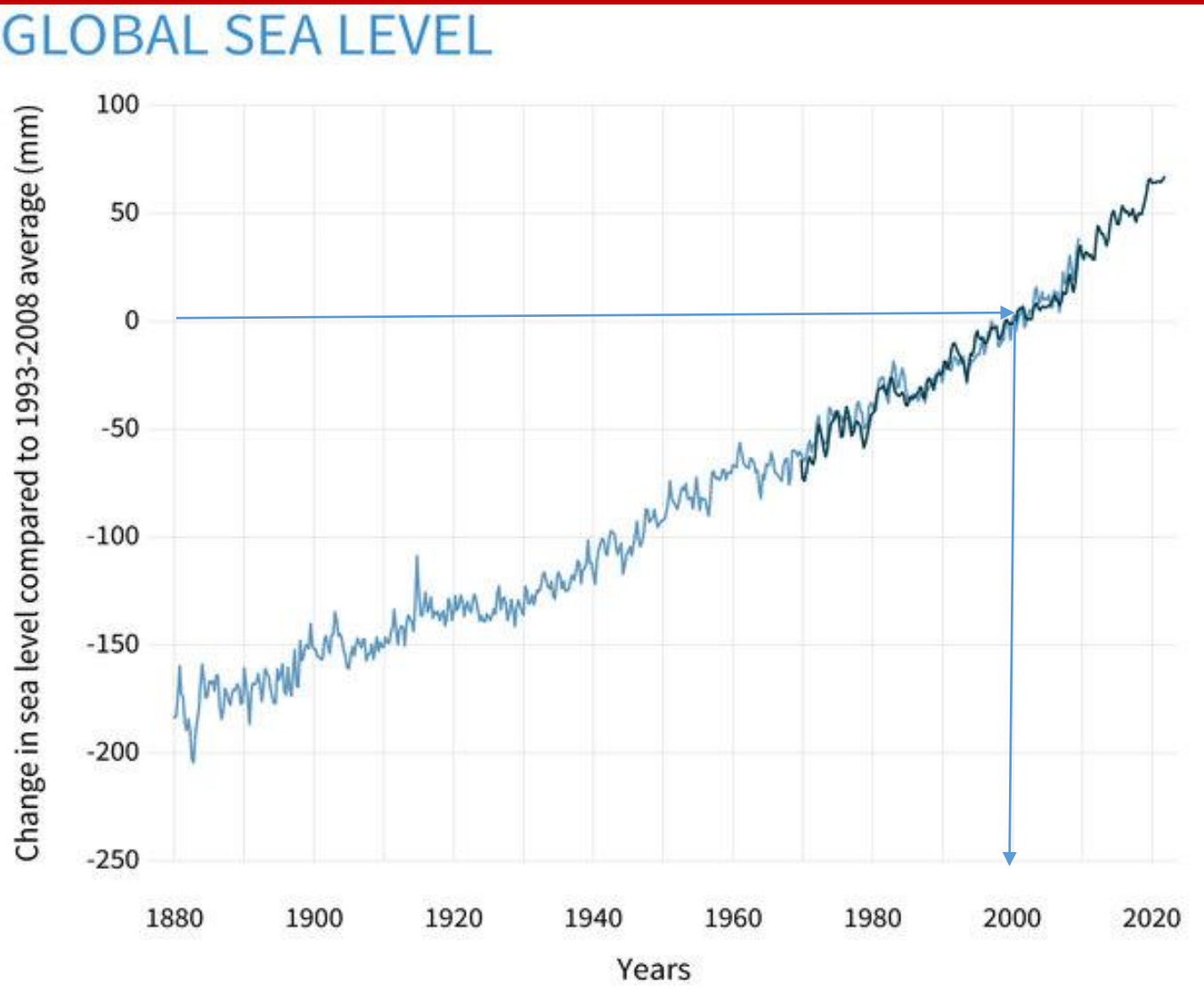
IPCC Report AR6 : Major Impacts

(2) Sea levels will continue to rise:

- Global average sea level has risen 8–9 inches (21–24 centimeters) since 1880.
- In 2021, global sea level set a new record high—97 mm (3.8 inches) above 1993 levels.
- The rate of global sea level rise is accelerating:
- It has more than doubled from 0.06 inches (1.4 millimeters) per year throughout twentieth century to 0.14 inches (3.6 millimeters) per year from 2006–2015.
- High-tide flooding is now 300% to more than 900% more frequent than it was 50 years ago.

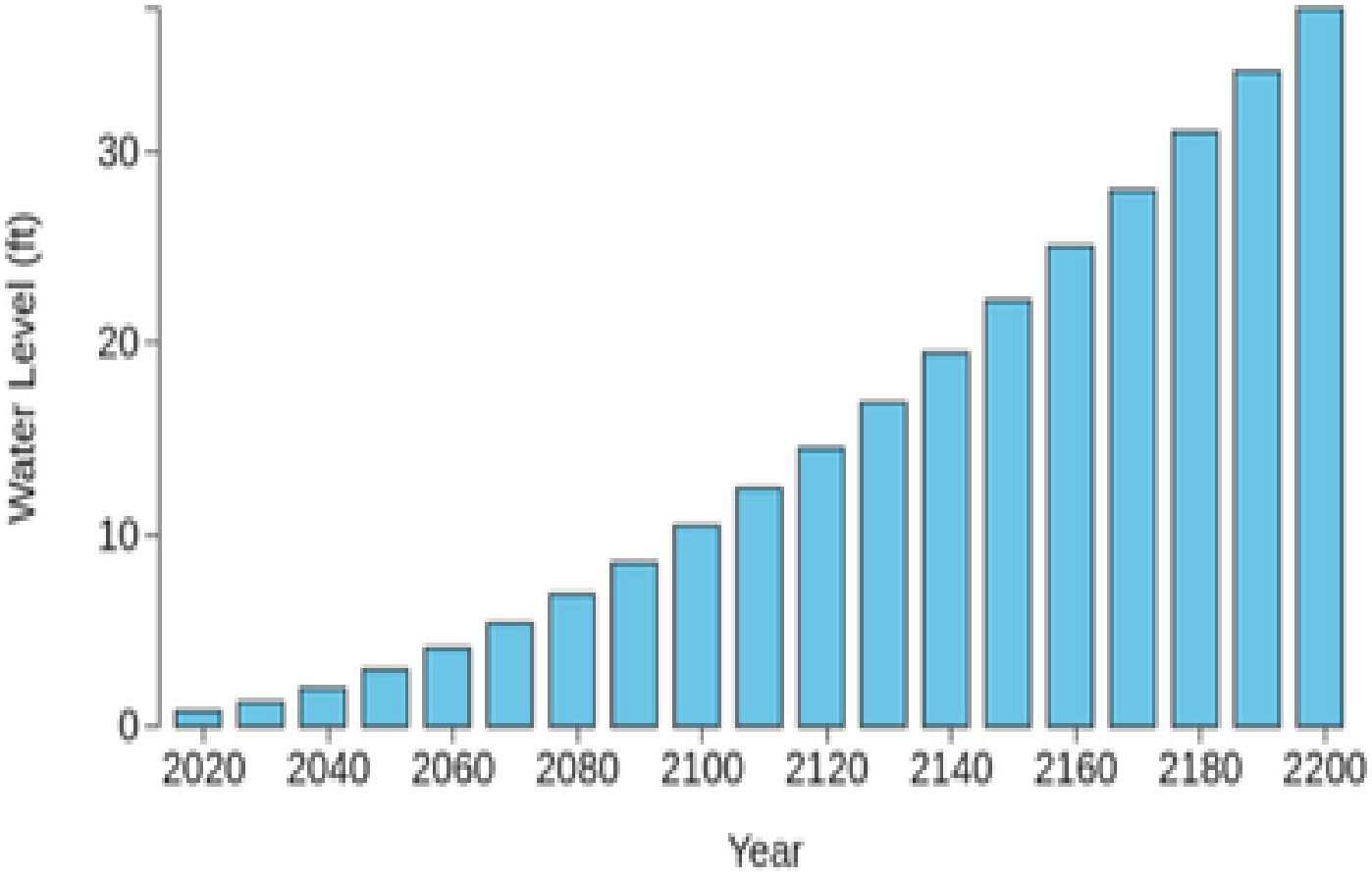


Source :https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

IPCC Report AR6 : Major Impacts

(2) Sea levels will continue to rise:

- As global warming occurs, ice caps melt at a rapid pace, meaning sea levels rise, and towns and cities around coastal areas are in danger of being swallowed up by the oceans.
- Research published in the Nature Journal suggests that if nothing is done, sea levels could rise by more than 1meter by 2100 and by 15 meters over the next 500 years.



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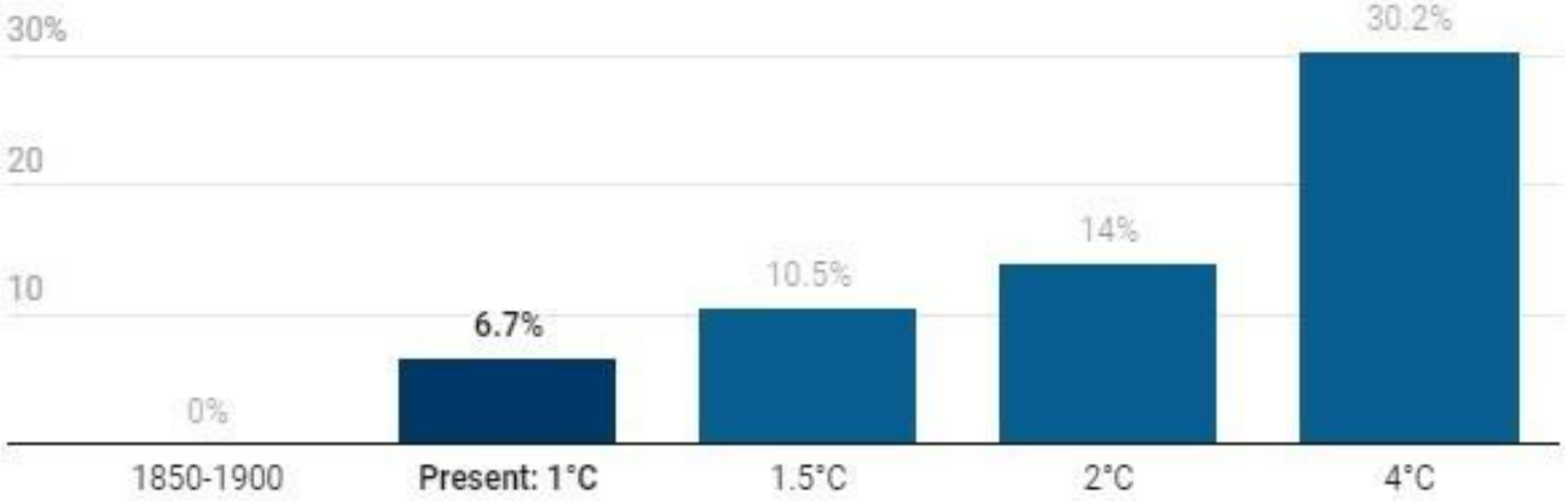
IPCC Report AR6 : Major Impacts

(2) More frequent of extreme events :-Floods & Droughts

Extreme storms get wetter as temperatures rise

As temperatures rise, the intensity of storms increases, the IPCC's latest assessment report shows. The chart shows how much wetter heavy one-day storms that historically occurred about once every 10 years are likely to become as temperatures rise.



Compared to the 1850-1900 average. 1° Celsius increase = 1.8° Fahrenheit increase.

Chart: The Conversation/CC-BY-ND • Source: IPCC Sixth Assessment Report • Get the data • Download image

Source : IPCC Report-AR6 (2022)

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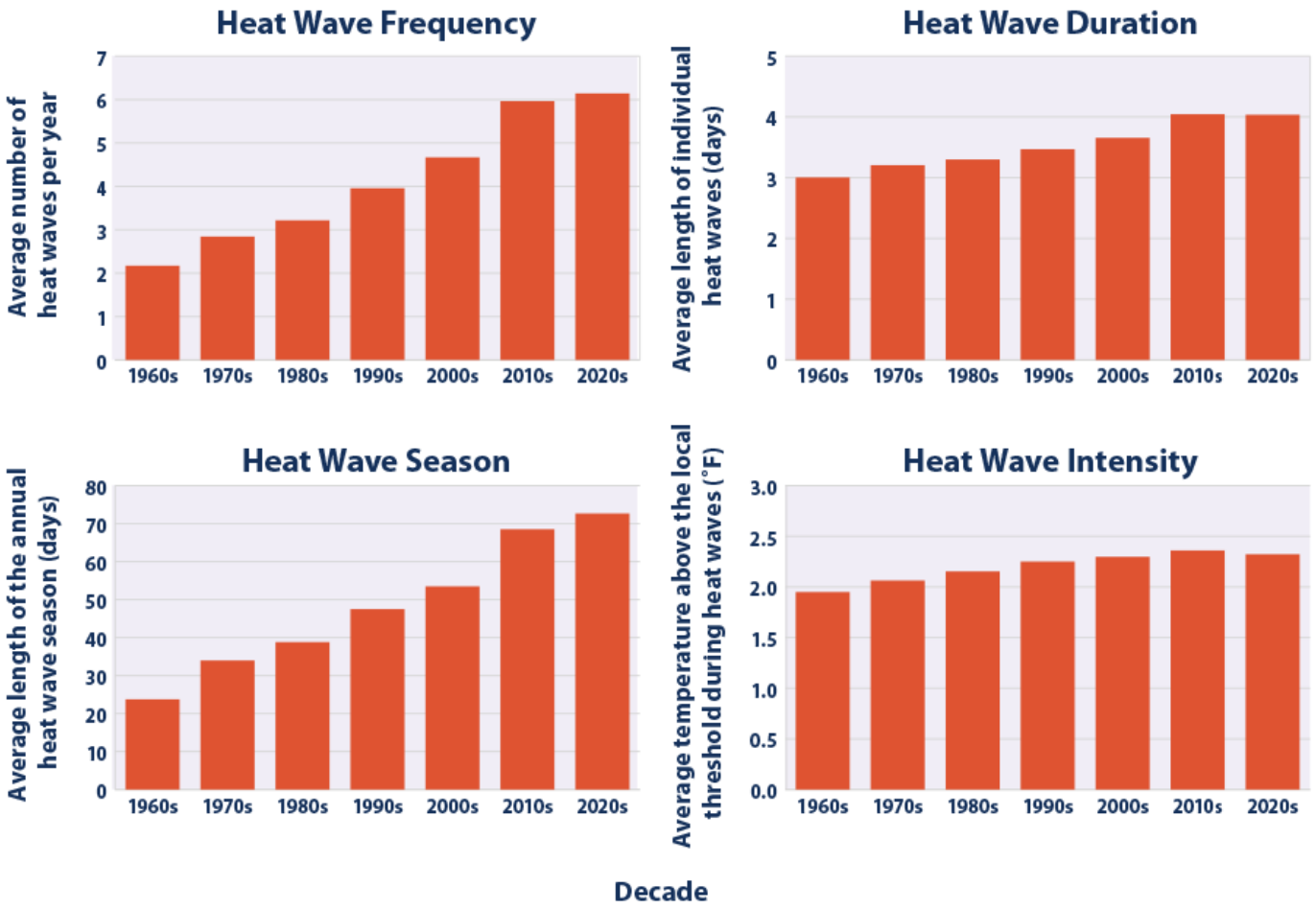
IPCC Report AR6 : Major Impacts

(2) More frequent of extreme events :- Heat/cold waves



Source : https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves & Data source: NOAA, 2022)

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IPCC Report AR6 : Major Impacts

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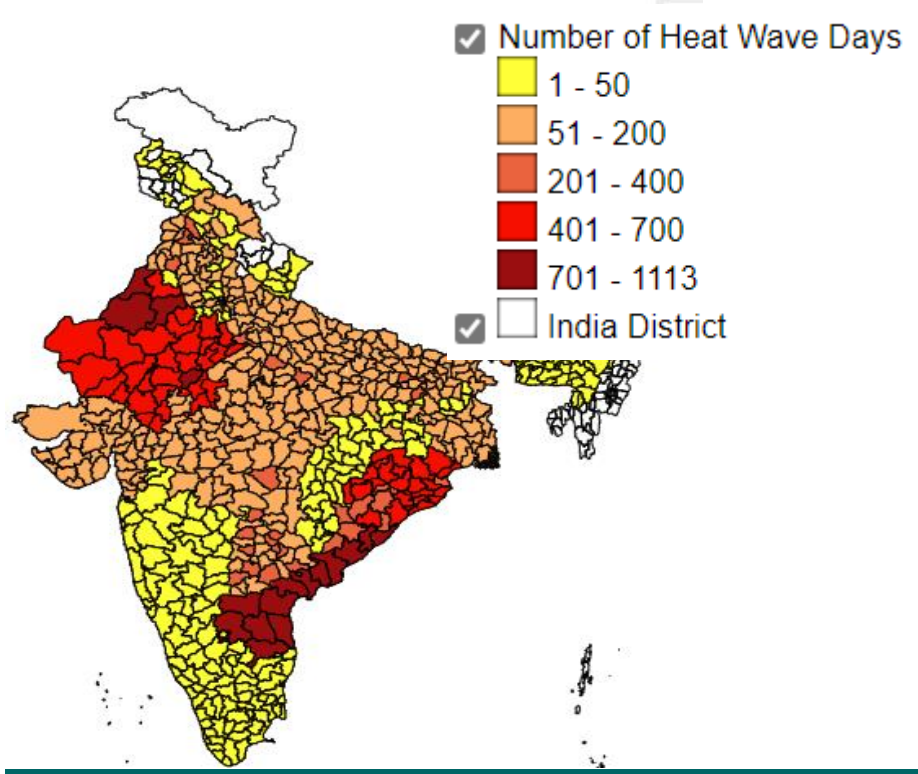
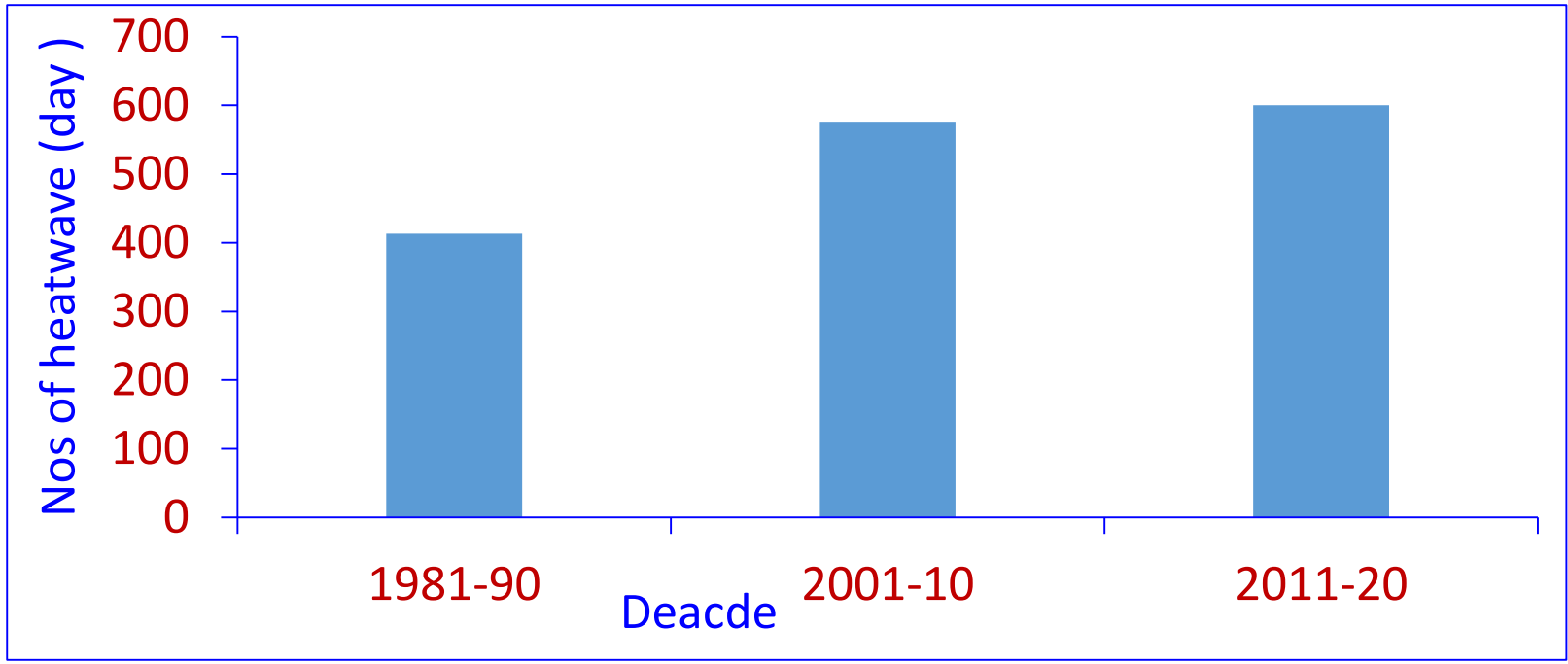


Total Number of Disastrous Heat Wave Days in Annual during the Periods from 1969 to 2019
(Based on data from IMD Publications Annual Disaster Weather Report)



- **India experiences its hottest March-2022 in 122 years**

(Source : https://qz.com/india/2156332/india-experiences-its-hottest-march-in-122-years)

IPCC Report AR6 : Major Impacts

(2) More frequent of extreme events :- Heat/cold waves

- In the recent past, heatwave gripped parts of the USA & Canada for days, breaking records.
- Canada recorded **49.6 degrees Celsius** on June 29, 2021.
- Scientists have warned for some time that climate change will increase the frequency and intensity of heatwaves.
- A research study attributed the heatwave event to climate change.
- The researchers estimated that the extraordinary temperature rise was a one in a thousand-year event.
- But, if the current Green House Gas (GHG) emissions continue, an event so extreme could start occurring every 5 to 10 years by the 2040s.

Source : https://www.indiawaterportal.org/articles/heat-waves-extreme-weather-events-and-climate-change

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

Impacts on : Water resources

1) Climate change can affect the intensity and frequency of precipitation.
2) Warmer oceans increase the amount of water that evaporates into the air. When more moisture-laden air moves over land or converges into a storm system, it can produce more intense precipitation—for example, heavier rain and snow storms
3) Crop damage, soil erosion, and an increase in flood risk due to heavy rains
4) The increase in extreme precipitation and the expected decrease in total precipitation in dry regions showed that “it never rains, but it pours” pattern in those regions.

Source : https://www.epa.gov/climate-indicators/climate-change-indicators

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Impacts on : Water resources

5) "Climate change has already altered, and will continue to alter, the water cycle, affecting where, when, and how much water is available for all uses.

6) Climate change impacts include too little water in some places, too much water in other places, and degraded water quality. Some locations will be subjected to all of these conditions during different times of the year."






Source : https://www.epa.gov/climate-indicators/climate-change-indicators

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Impacts on Water resources:JAU's Research Outcomes-Rainfall

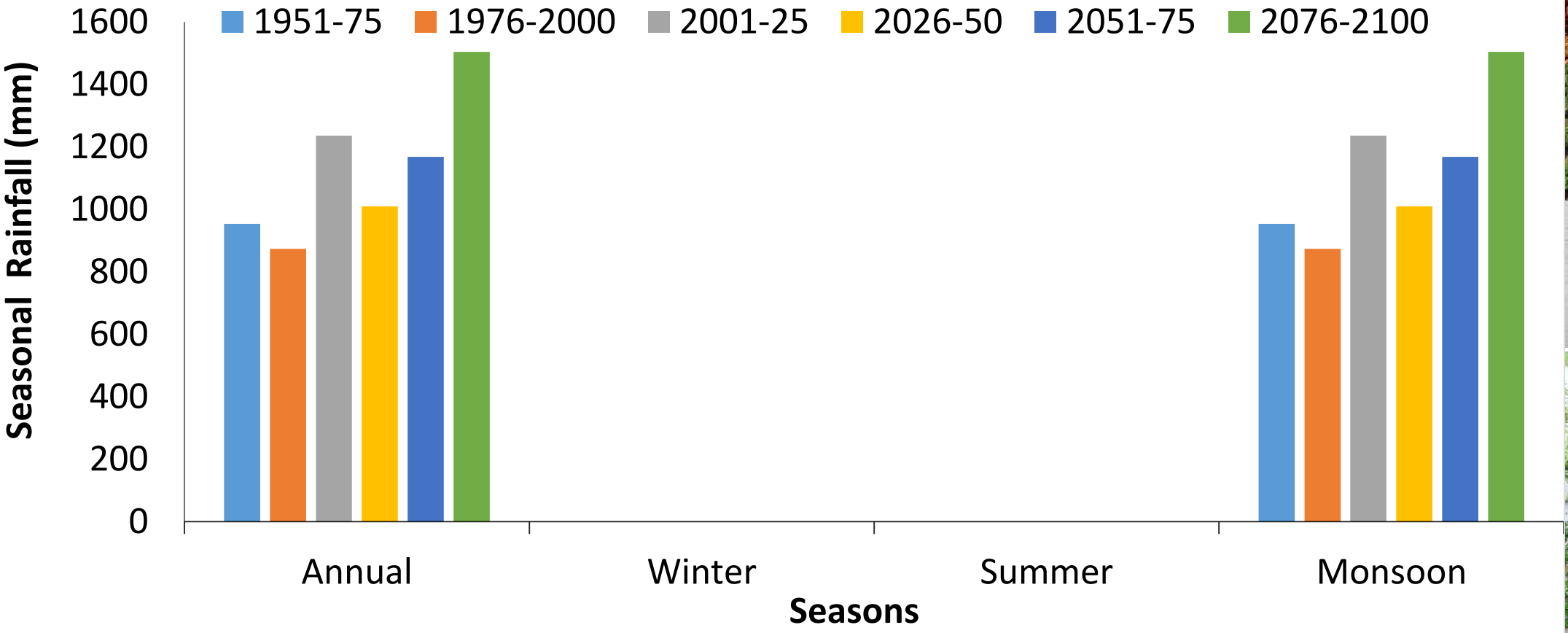

Fig. 1: Trend of seasonal rainfall of various season

Source : NICRA Project Report, JAU, Junagadh submitted to ICAR,-IIWM, Bhubneshwar .

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Impacts on Water resources:JAU's Research Outcomes-Rainfall

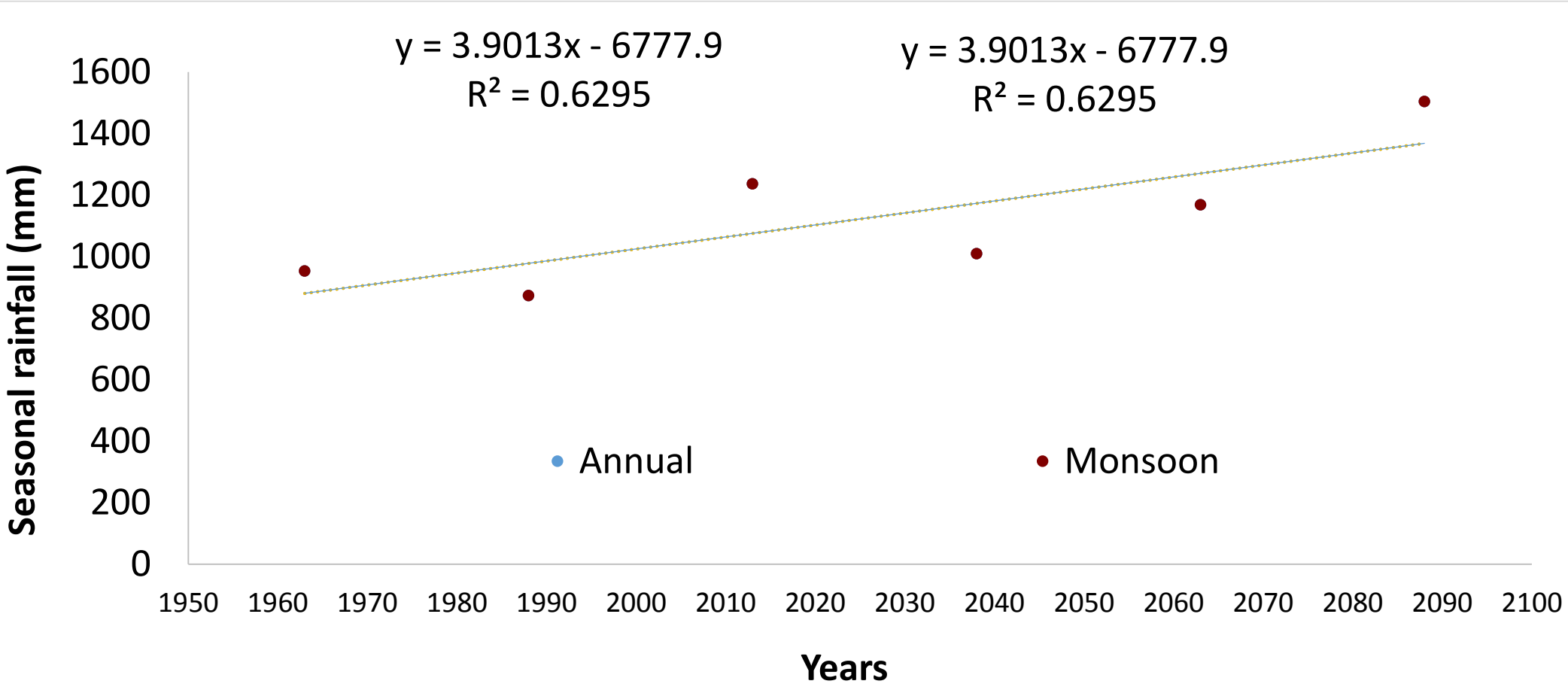

Fig. 2: Trend of seasonal rainfall during different decades

Source : NICRA Project Report, JAU, Junagadh submitted to ICAR,-IIWM, Bhubneshwar .

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Impacts on Water resources:JAU's Research Outcomes-Runoff

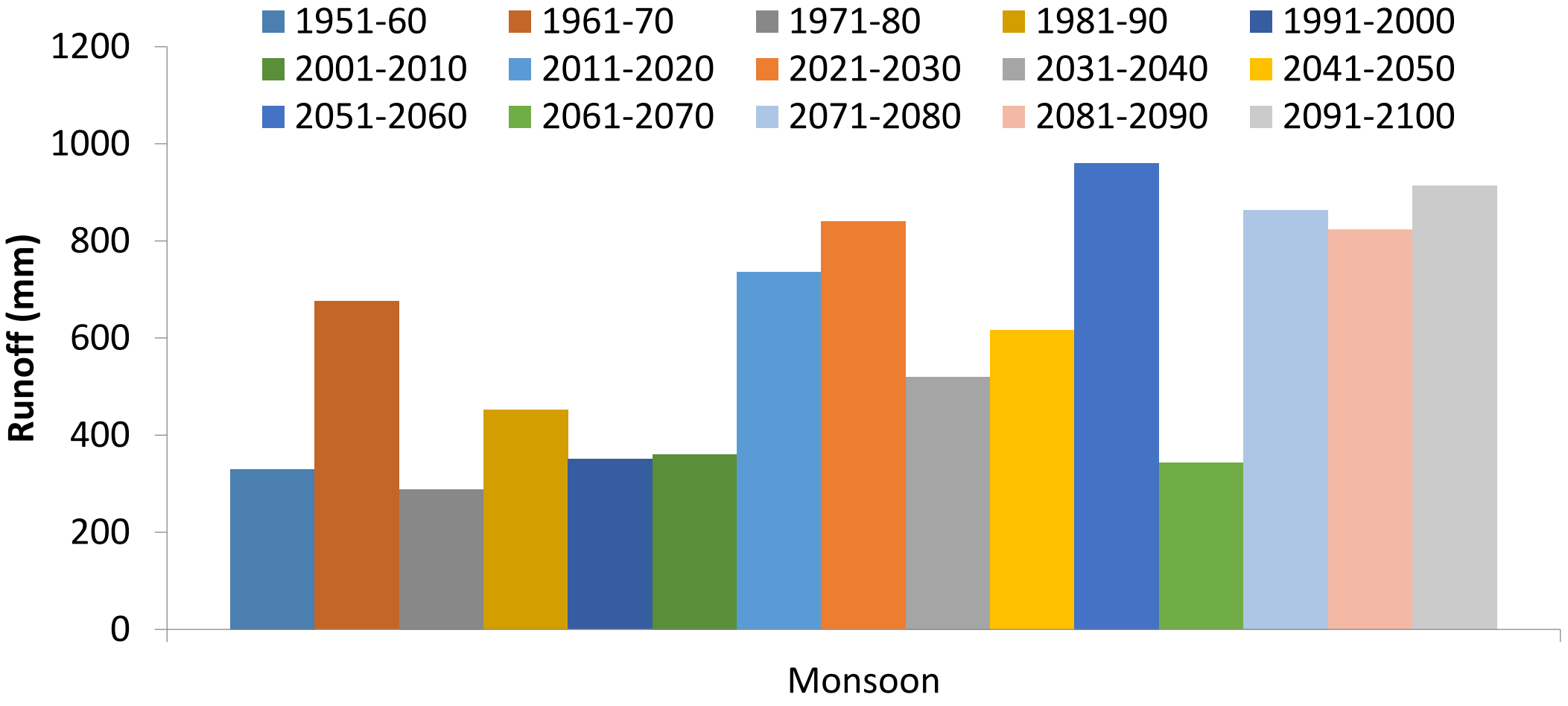

Fig. 3 : Trend of Seasonal runoff for the different decade of 1951-2100

Source : NICRA Project Report, JAU, Junagadh submitted to ICAR,-IIWM, Bhubneshwar .

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Impacts on Water resources:JAU's Research Outcomes-Runoff

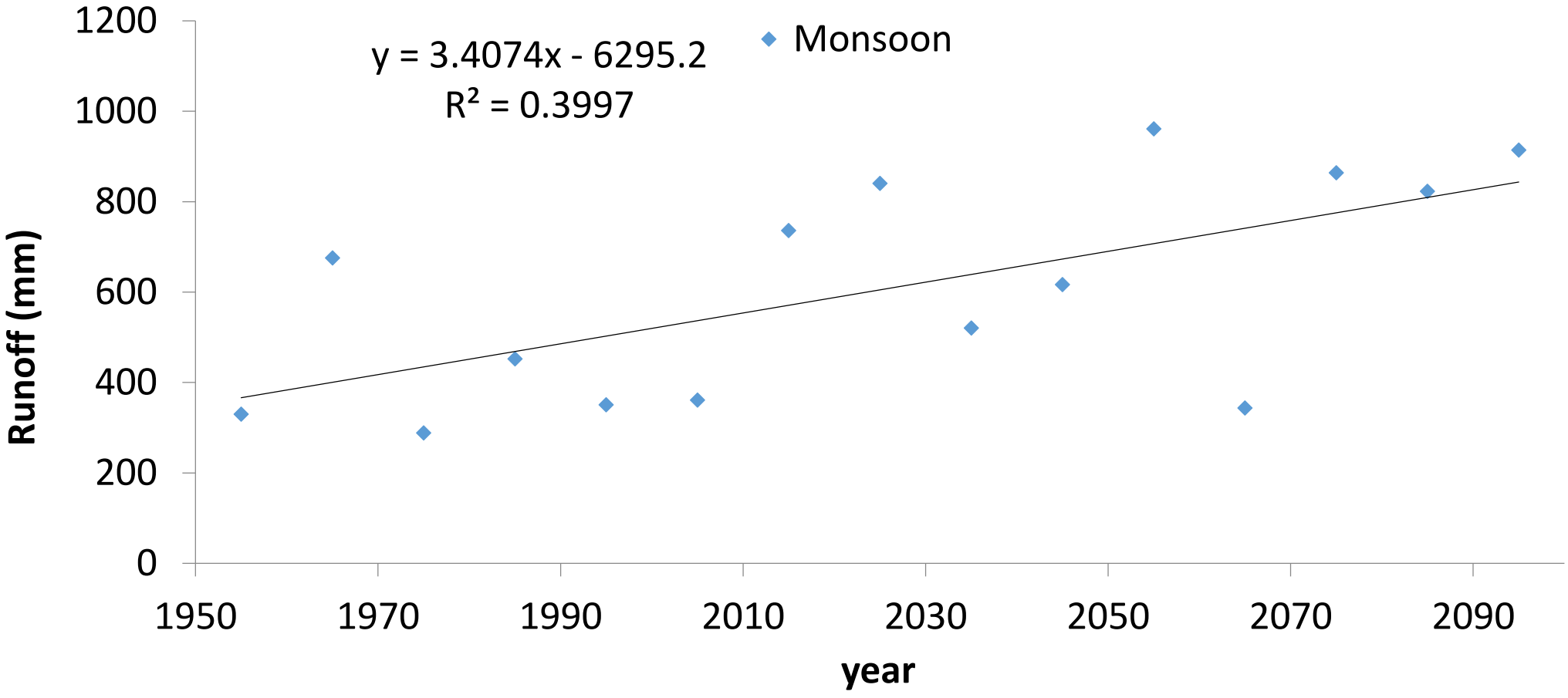

Fig. 4 : Trend of seasonal runoff during 1951-2100

Source : NICRA Project Report, JAU, Junagadh submitted to ICAR,-IIWM, Bhubneshwar .

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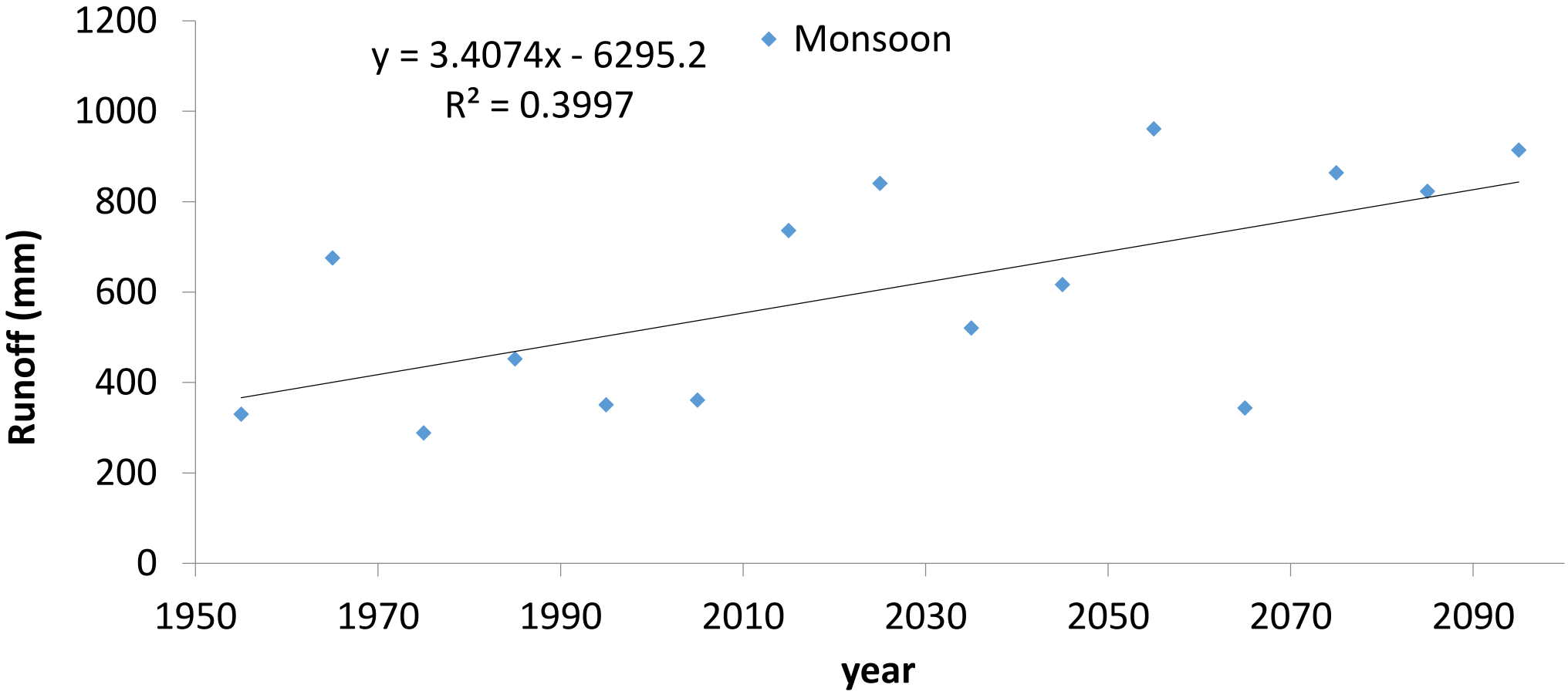
Impacts on Water resources:JAU's Research Outcomes-Runoff



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Impacts on : Sunshine radiation/humidity

1) Higher surface temperatures will lead to more moisture, aerosols and particulates in the atmosphere, which may result in less solar radiation and more cloudy days.






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Impacts on : Crop Water Requirements

1) All Hot Weather crops (Millet, Ground nut, Maize, Small vegetables and Tomato) shows rise in crop water requirements in all future periods (2011-2030, 2046-2065 and 2080-2099) as compared to base period 2003-2009.

2) In the period 2011-2020, all Rabi crops (Wheat, Sorghum, Maize, Small Vegetables, Tomato, Gram and Cowpeas) shows negligible fall in water requirement, whereas considerable rise in water requirement of all Rabi crops has been seen in other future periods (2021-2030, 2046-2065 and 2080-2090).

Source : Parekh, F. and Prajapat, K P. (2013). Climate change impacts on crop water requirement for sukhi Reservoir project. International Journal of Innovative Research in Science, Engineering and Technology . 2(9) : 4685-4692

Impacts on : Crop Water Requirements

3) Researches shows that due to increase in Maximum and Minimum temperature and decrease in Relative humidity in future years, crop water requirement will increase, also average rainfall is showing decreasing trend until end of 2065 and showing increasing trend until end of 2090.






Source : Parekh, F. and Prajapat, K P. (2013). Climate change impacts on crop water requirement for sukhi Reservoir project. International Journal of Innovative Research in Science, Engineering and Technology . 2(9) : 4685-4692

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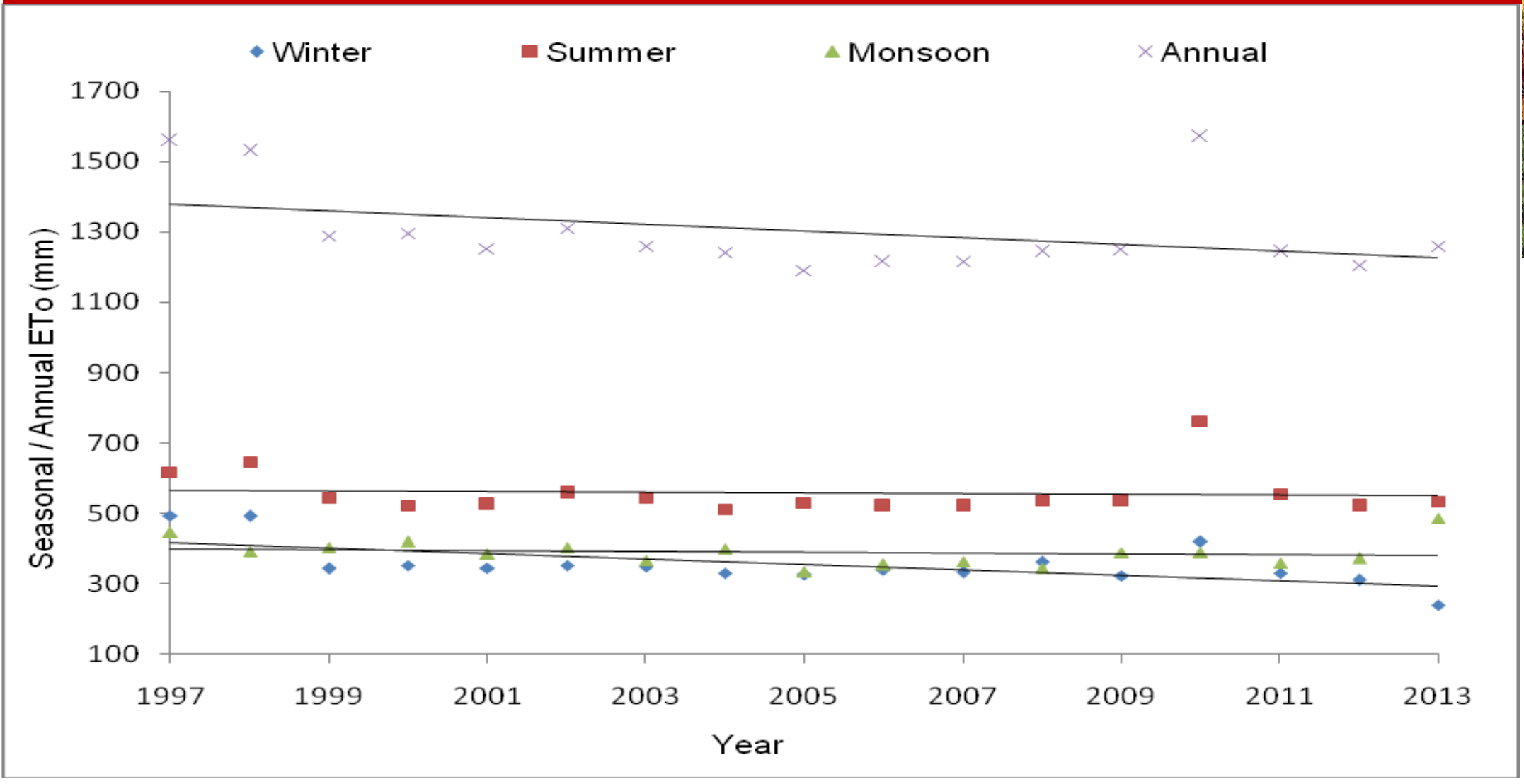
Impacts on : Crop Water Requirements: JAU's Research Outcomes



The trend of seasonal and annual reference evapotranspiration at Mang

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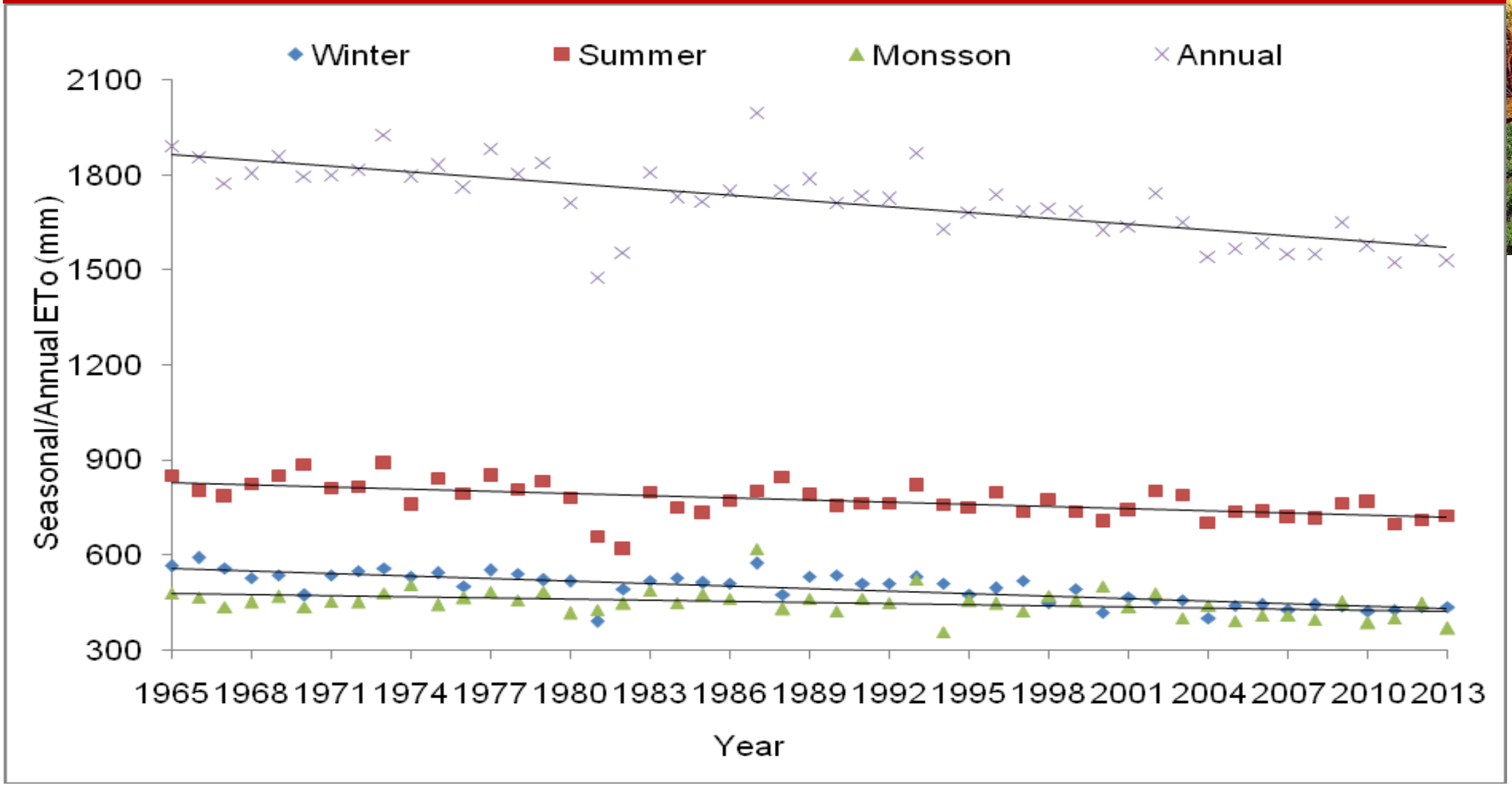

The trend of seasonal and annual reference evapotranspiration at Junagad

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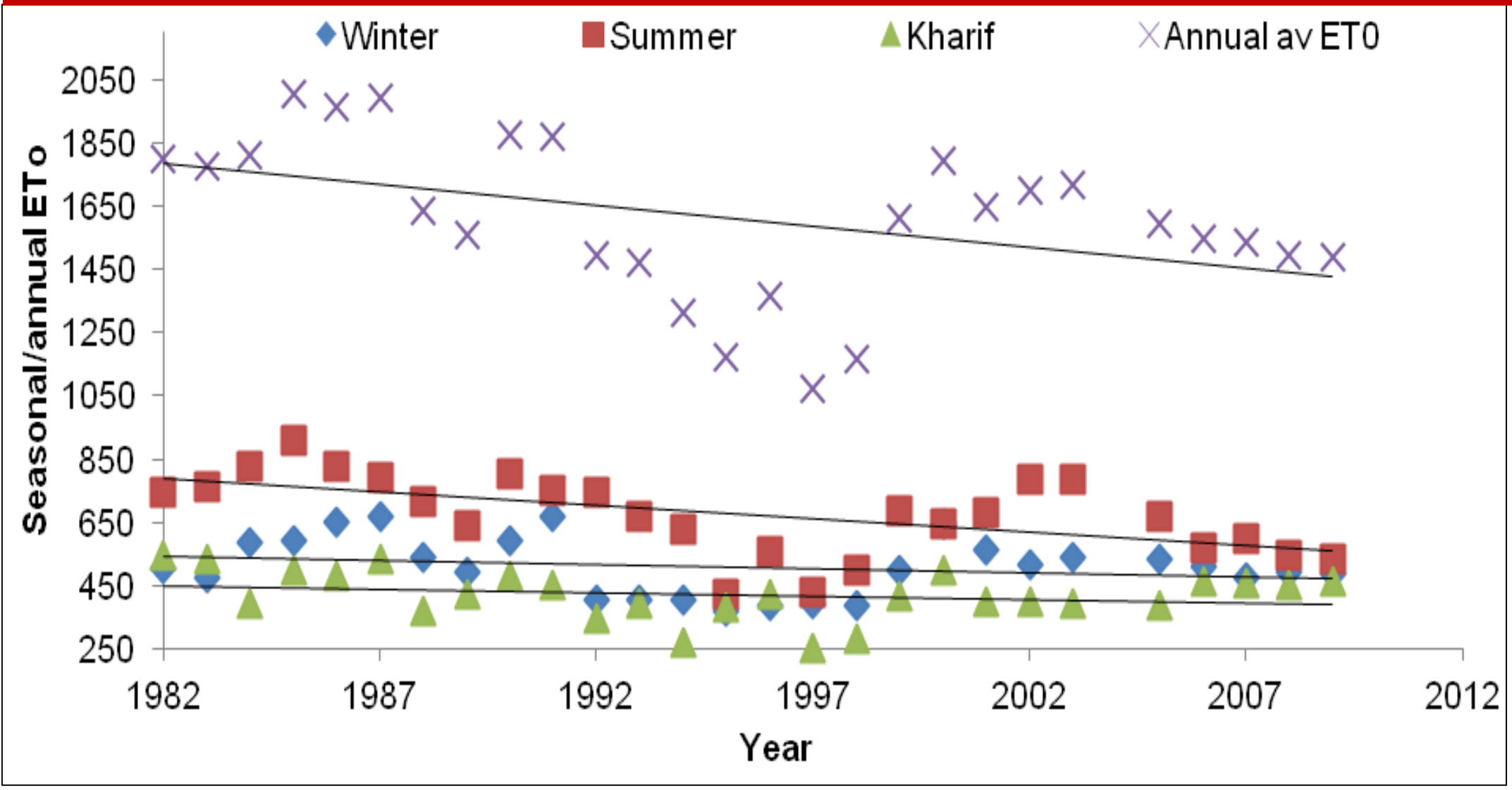

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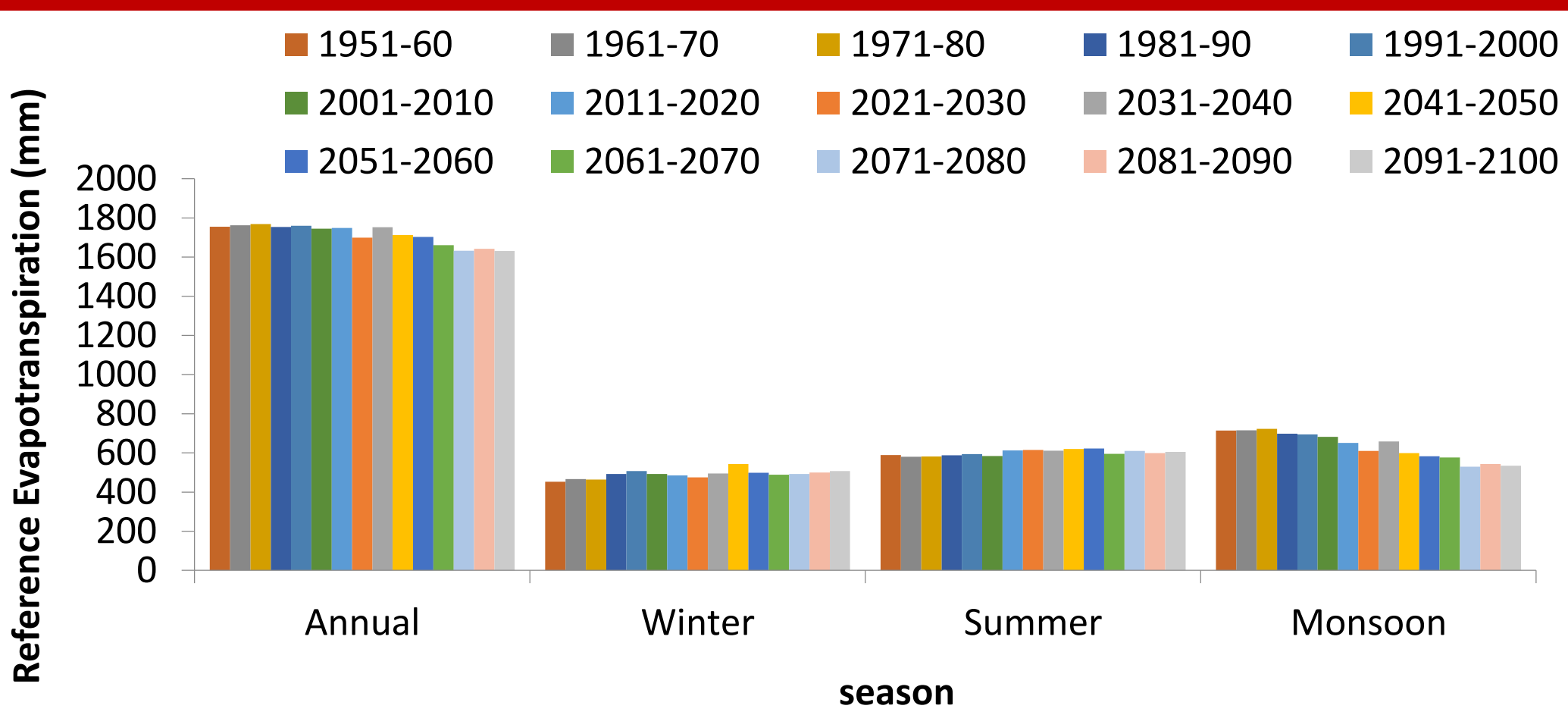

Fig. 3: The variation of decadal average of reference evapotranspiration (ETo) during different season for the period-1951-2100

Source : NICRA Project Report, JAU, Junagadh submitted to ICAR,-IIWM, Bhubneshwar .

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Impacts on : Crop Water Requirements: *JAU's Research Outcomes*

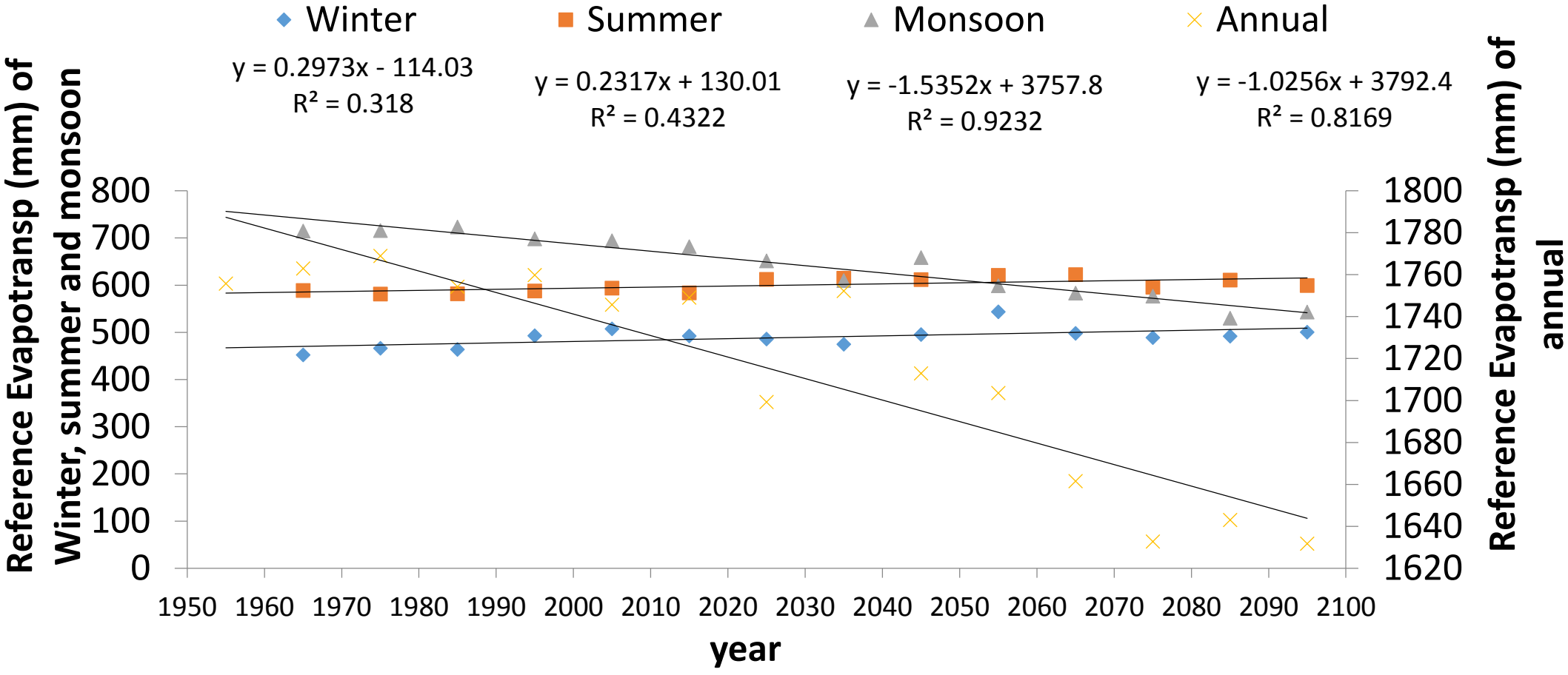

Fig. 3b: The trend of decadal average of reference evapotranspiration (ETo) during different season for the period-1951-2100

Source : NICRA Project Report, JAU, Junagadh submitted to ICAR,-IIWM, Bhubneshwar .

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Impacts on : Crop Yield

1) Higher levels of carbon dioxide in the atmosphere have a positive effect on photosynthesis and water retention, increasing crop yields, though often at a cost to nutrition.
2) Higher temperatures also affect the length of growing seasons and accelerate crop maturity.
3) Though rising CO_2 can stimulate plant growth, it also reduces the nutritional value of most food crops.
4) Rising levels of atmospheric carbon dioxide reduce the concentrations of protein and essential minerals in most plant species, including wheat, soybeans, and rice.
5) This direct effect of rising CO_2 on the nutritional value of crops represents a potential threat to human health.






Source : . https://doi.org/10.17226/1911. Managing Water Resources in the West Under Conditions of Climate Uncertainty: A Proceedings. Washington, DC: The National Academies Press.

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

Impacts on : Crop Yield

6) **As climate change alters temperature and rainfall patterns, yields of some crops are increasing while others decline.**

7) **It was estimated that climate change was reducing global rice yields by 0.3% and wheat yields by 0.9% on average each year while some more drought-tolerant crops have benefited from climate change.**

8) **Yields of sorghum, which many people in the developing world use as a food grain, have increased by 0.7% in sub-Saharan Africa and 0.9% yearly in western, southern and southeastern Asia due to climate shifts.**






Source : . https://doi.org/10.17226/1911. Managing Water Resources in the West Under Conditions of Climate Uncertainty: A Proceedings. Washington, DC: The National Academies Press.

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

Impacts on : Crop Yield - JAU's Research Outcomes-Sweet corn

Future climate change impacts on sweet corn crop under surface drip irrigation with umlch having irrigation/fertigation schedules at 1.0 ETc and 1.0 RDF

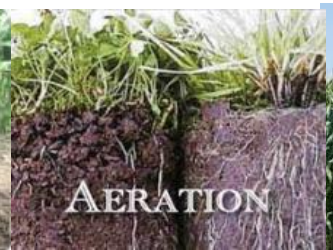
Year	Warming trend as per Anonymous (2015)	CO_2 concentration in atmosphere (ppm) as per AquaCrop.	Simulated yield of sweet corn cob (ton/ha) by AquaCrop model	Increase (+) / Decrease (-) in yield over present (%)	Water footprints (liter/kg)	Increase (+) / Decrease(-) in Water footprints over present (%)
2020-21	Observed climate data	411	23.12	-	133.50	-
2050-51	+1 °C	498	24.112	+4.29	136.72	+2.41
2099-2100	+2.5 °C	538	24.278	+5.01	138.89	+4.04

(Source : Rank, P H. (2022). Ph D thesis submitted to JAU, Junagadh)











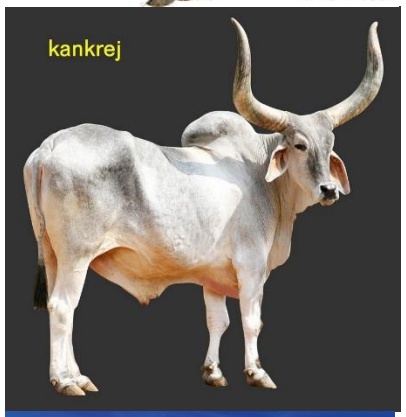

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

IPCC Report AR6 : Suggestive measures

- **The IPCC(Intergovernmental Panel on Climate Change) gave prominence to 3 special aspects:**

(1) Put drastic cut in use of fossil fuels:

- It should be reduced drastically as soon as possible, as a matter of urgency.
- Carbon dioxide (CO2) emissions reductions - by switching to an electric or **hybrid** car.
- Increase use of renewable energy productions.
- The focus must be placed on methane emissions, which would help reverse climate change and improve air quality around the world.
- The GHGs emission like Nitrous oxide(N_2O) & Methane(CH_4) from agriculture/animal husbandry must be reduced through adoption of efficient cultivation practices and milching/ farming animals .
- **We are close to reaching irreversible tipping points.**



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IPCC Report AR6 : Suggestive measures

- **The IPCC(Intergovernmental Panel on Climate Change) gave prominence to 3 special aspects:**

(2) Changes in out diet habits :

- The livestock industry is one of the most polluting industries.
- Rearing of efficient draught and milching animals.
- It is necessary to reduce the demand for meat and dairy.

(3) Greener cities :

- The traditional urban organization must change as soon as possible towards sustainable and more environmentally friendly urban planning (GREEN CITY & GREEN BULDING).

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

IPCC Report AR6 : 5 Tips to limit our impact on the Environement

Solving our greatest environmental challenges will require profound changes in **business policies** and **practices to limit our ecological footprint**

(1) Opt for a green supplier:

(2) Adopt recycling:

(3) Reduce your digital footprint:

(4) Choose ecological transport:

(5) Offset your carbon footprint:

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

IPCC Report AR6 : 5 Tips to limit our impact on the Environement

Solving our greatest environmental challenges will require profound changes in **business policies** and **practices** **to limit our ecological footprint**

(1) Opt for a green supplier:

- We should opt for a 100% renewable energy supplier, participate in a greener world while saving on our electricity bills;
- Energy generation from bio-mass /agricultural wastes instead of burning in field.
- Think for the Design of green building-minimum energy use.
- Reduce energy inputs in farming by adopting concept of minimum tillage/zero tillage.
- Minimize use of plastic/energy/chemical inputs through natural farming approach.

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

IPCC Report AR6 : 5 Tips to limit our impact on the Environement

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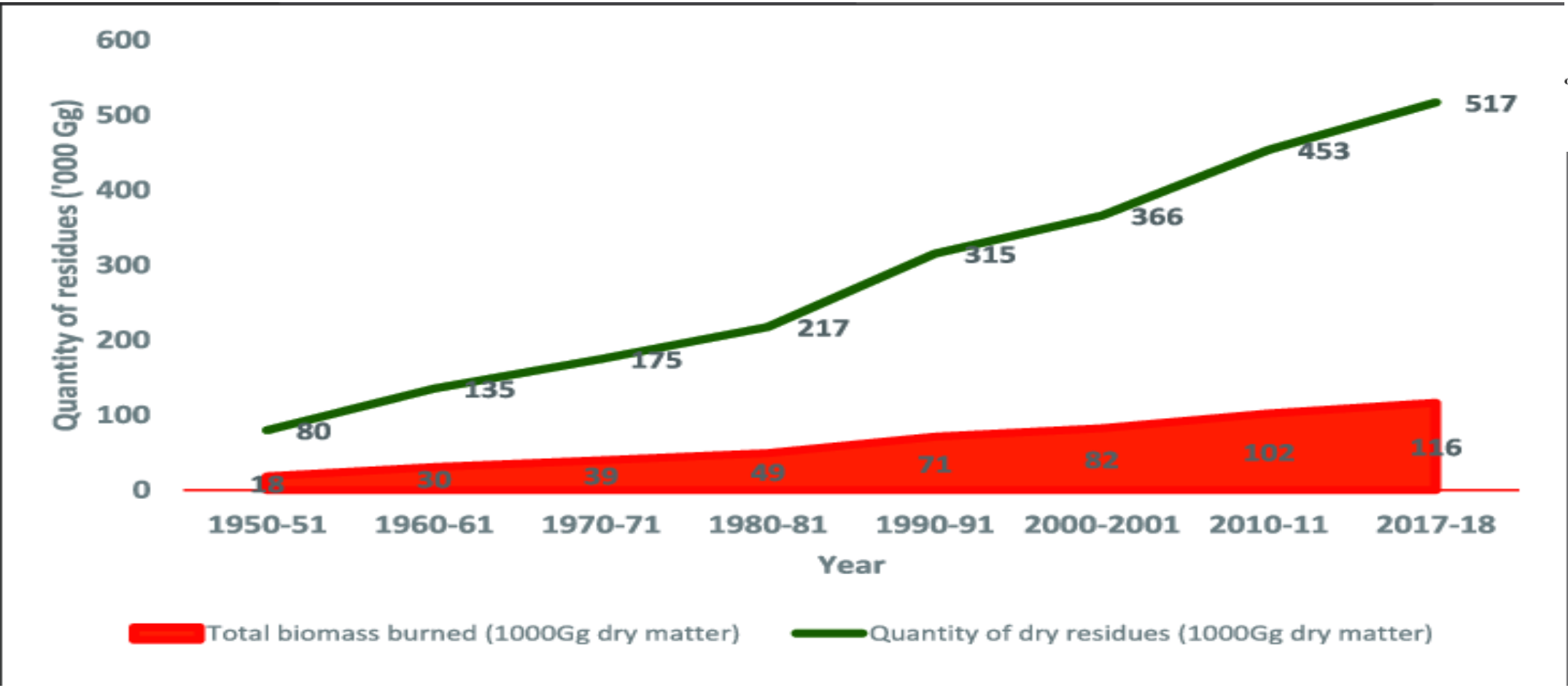
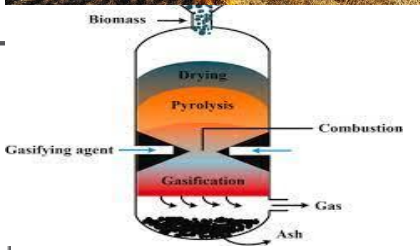




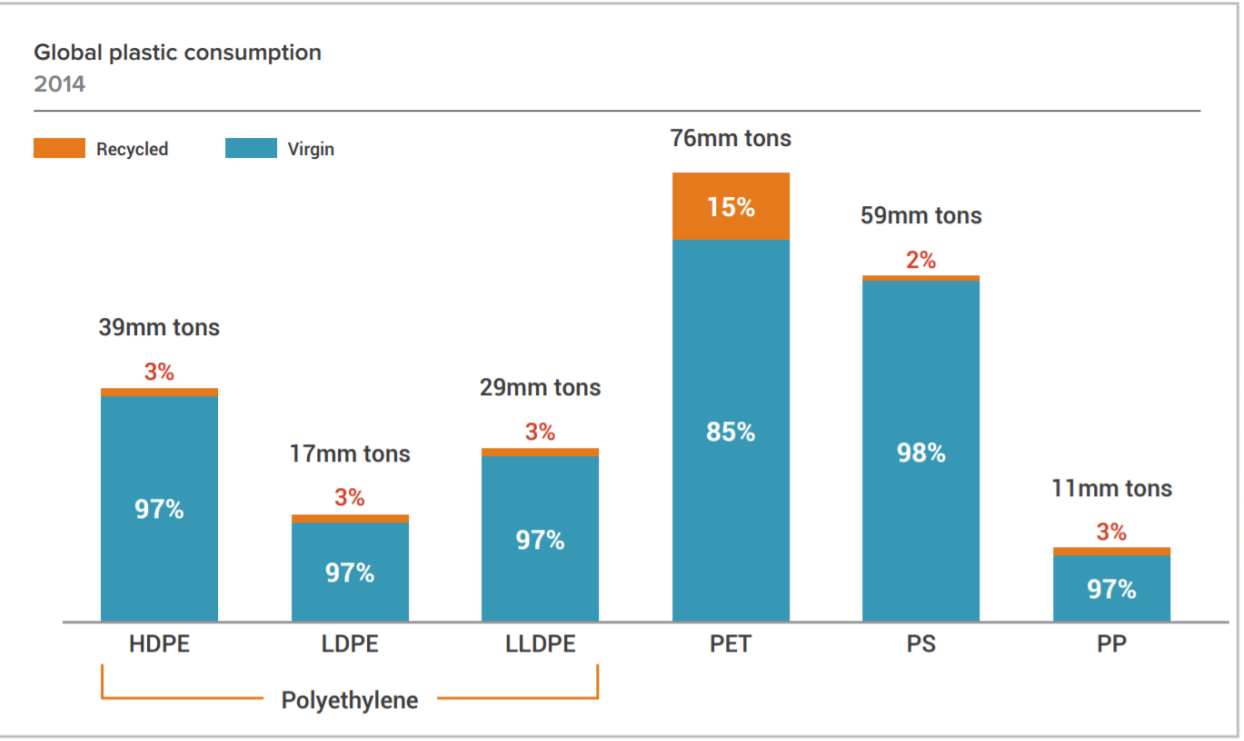
Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

IPCC Report AR6 : 5 Tips to limit our impact on the Environement

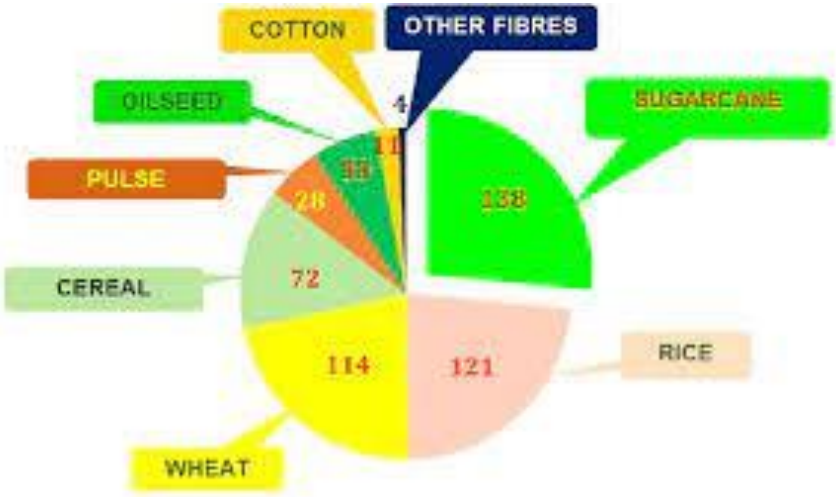
Solving our greatest environmental challenges will require profound changes in **business policies** and **practices** **to limit our ecological footprint**

(2) Adopt recycling:

- We should give a second life to our waste. Think about recycling all sorts of items, including: glass, paper, cardboard, aluminum, **and** plastic;



Agricultural waste in India



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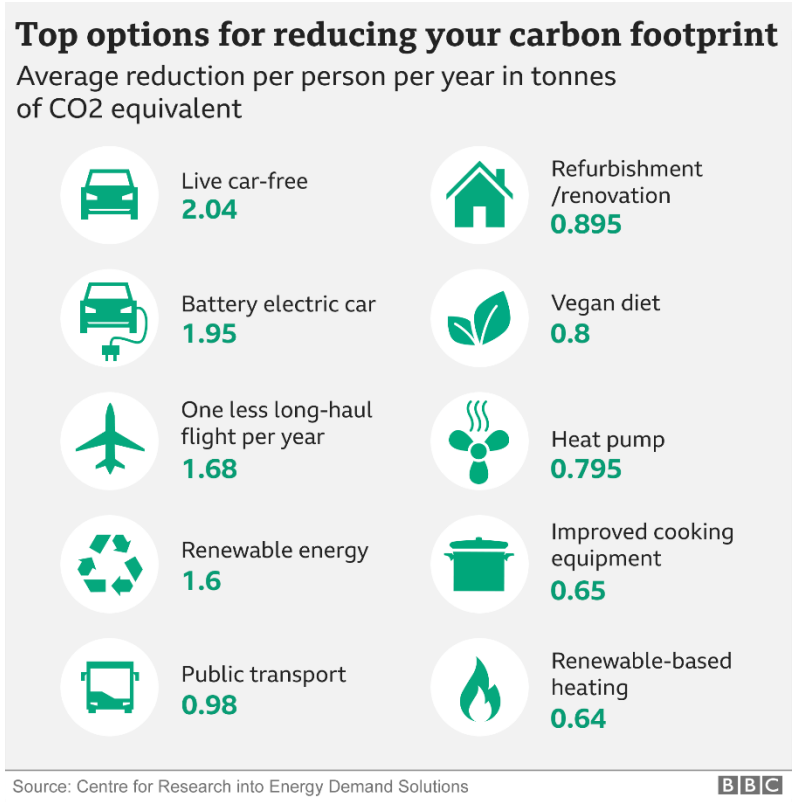
IPCC Report AR6 : 5 Tips to limit our impact on the Environement

Solving our greatest environmental challenges will require profound changes in **business policies** and **practices** **to limit our ecological footprint**

(3) Reduce your carbon footprint:

- by adopting the right practices, we can limit the carbon footprint linked to the various uses/services/goods/ equipment in our life;



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Solving our greatest environmental challenges will require profound changes in **business policies** and **practices to limit our ecological footprint**

(4) Choose ecological transport:

- by opting for public transport or an ecological means of transport such as an electric vehicles, we can limit the environmental impact of your travels;

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IPCC Report AR6 : 5 Tips to limit our impact on the Environement

Solving our greatest environmental challenges will require profound changes in **business policies** and **practices to limit our ecological footprint**

(5) Offset your carbon footprint:

- by supporting an environmental project like the Gandhi project, you are helping to limit greenhouse gas emissions into the atmosphere.
- Chemical Fertilizers cause more than 2% of global emissions.
- Agricultural use of these fertilizers leads to the release of nitrous oxide (N_2O)—a greenhouse gas 265 times more potent than carbon dioxide (CO_2) over a century.
- Reduce methane/ emissions by adoption and management of agricultural practices. Methane is also a powerful greenhouse gas.

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IPCC Report AR6 : 5 Tips to limit our impact on the Environement

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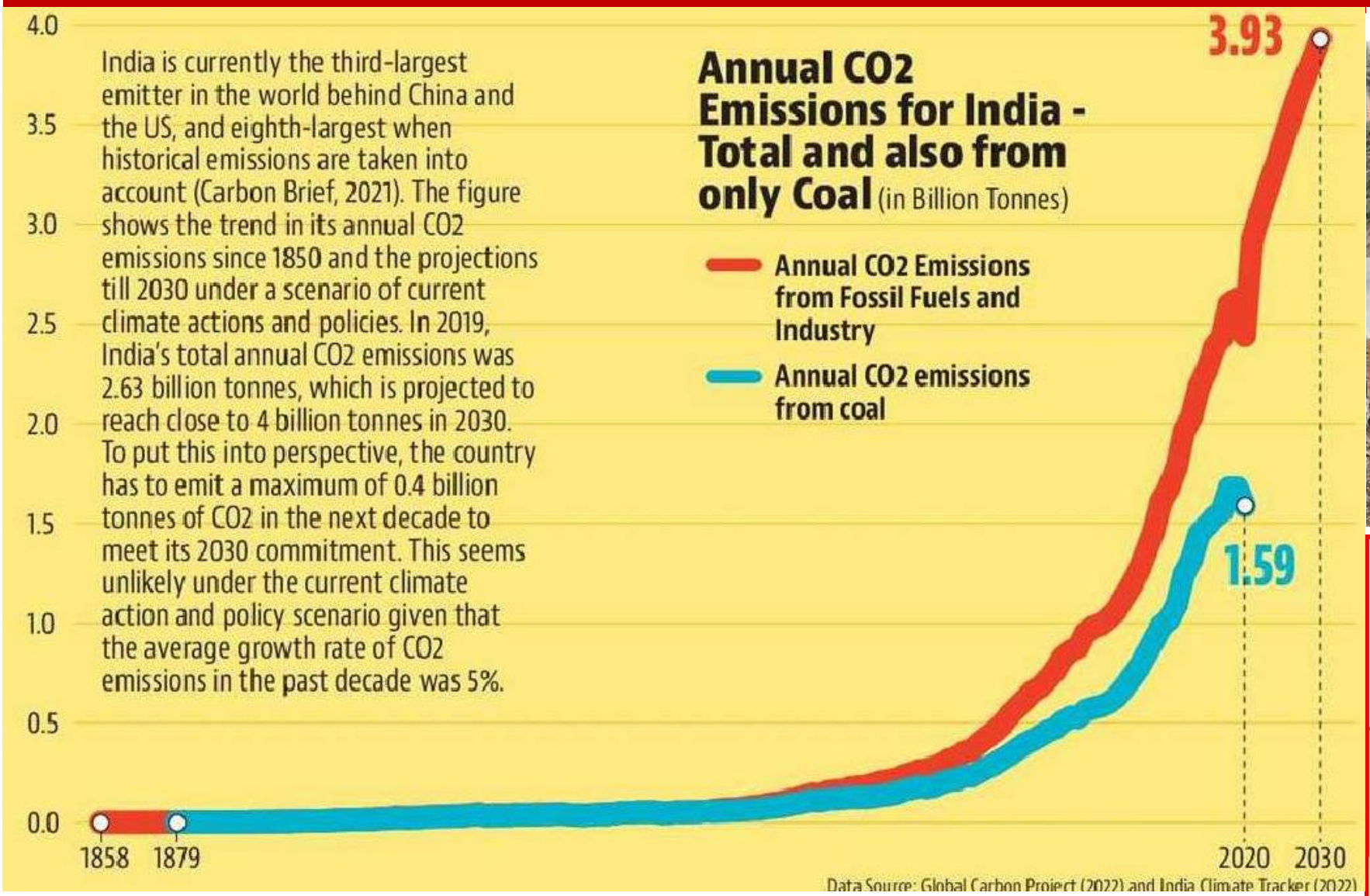
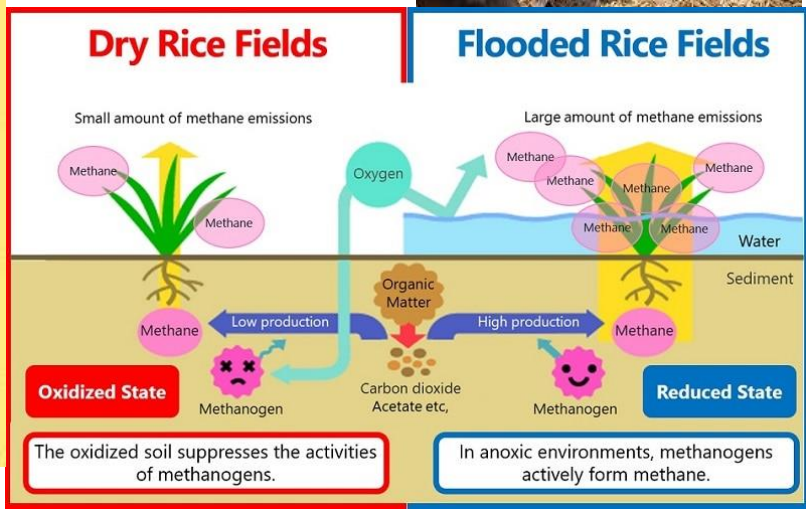
(5) Offset your carbon footprint:

- **Methane** : Over a **20-year period**, it is **80 times more** potent at warming than carbon dioxide. **Methane** has accounted for **roughly 30 per cent** of **global warming** since pre-industrial times and is proliferating faster than at any other time since record keeping began in the 1980s.
- **Reduce animals** : Shifting dietary patterns towards less meat and dairy products could play a central role."
- **Extend /Intensify Forestation** : Extensively & Intensively
- **Enhance carbon sequestration** in soil by adopting either through Organic / Natural Farming.

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

India's Net-Zero Emission Task- 1. Business as usual will not do





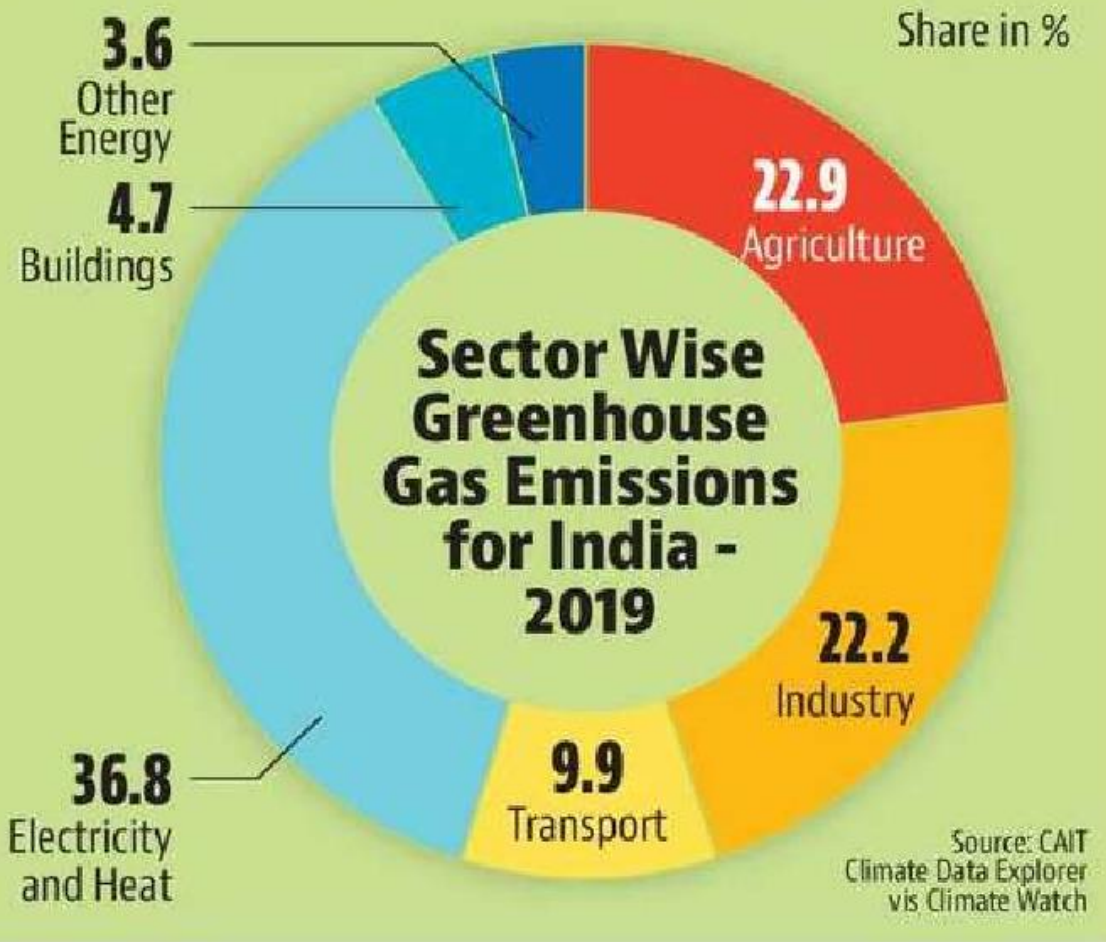
(Source : Hindustan Times, 26.09.2022)

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

India's Net-Zero Emission Task- 2. Sources of GhG emissions in India

What is the biggest source of GHG emissions in India?

One of the main drivers for historical emissions in India, and globally, has been the use of carbon intensive sources for energy production. The figure shows the contribution of various sectors and industries to GHGs. The largest single source of greenhouse gas emissions is the fossil fuel industry, or the burning of coal, natural gas and oil for electricity and heat production, transportation and in industrial processes (chemical, metallurgical, minerals), accounting for 73% of total GHG emissions in the country. About 23% of GHG emissions come from the agriculture, forestry and land-use sector, which are mainly in the form of crop and livestock cultivation, crop burning, manure and deforestation. Finally, only 4% of the greenhouse gas emissions come from other energy sectors such as fuel extraction, refining and processing.



(Source : Hindustan Times, 26.09.2022)

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

India's Net-Zero Emission Task- 3. Increase renewable energy production replacing fossil fuels

Share of primary energy production from renewable energy

Country	1980	1990	2000	2010	2020
India	**13.45**	**8.54**	**6.38**	**6.58**	**9.31**
China	3.57	4.72	5.66	7.62	14.95
USA	4.42	4.72	4.03	5.84	10.66
UK	0.49	0.68	1.13	3.66	17.95
Germany	1.48	1.34	2.89	8.79	19.45
Russia	NA	4.9	6.73	5.92	6.62
Brazil	36.19	45.28	43.29	44.25	46.22

Data Source: BP Statistical Review of World Energy

(Source : Hindustan Times, 26.09.2022)

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

India's Net-Zero Emission Task- 3. Increase renewable energy production replacing fossil fuels

- Transitioning to a net-zero world will requires structural change in the economic processes of production & consumption
- Energy sector holds the key as it the source for more than 70% total GHGs emissions.
- India lags behind in share of renewables in total Energy production
- India has to replace fossil fuels with renewable energy and increasing the share of renewable energy production which offers a way forward.
- Indeed most of the counties historically responsible for cumulative CO_2 emissions (UK, USA, Germany & China) have all taken massive strides in this direction by opting to invest in clean energy technologies in last decade.
- India have to overcome the dual problem of increasing investment in clean energy and efficiency, while at the same time gradually phasing out fossil fuels from its energy basket.

(Source : Hindustan Times, 26.09.2022)

Challenges Ahead under Changing Climate : Energy-Water-Food Nexus

India's Net-Zero Emission Task- 4. Requres to boost current pace of addition of renewable energy capacity

Installed Renewable Energy (in MW)

Financial Year 2022-23

Sector	Achievements (April-Aug 2022)	Cumulative Achievements (as on 31.08.2022)
Wind Power	847.1	41,204.68
Solar Power	5,306.18	59,302.7
Small Hydro Power	39	4,887.9
Biomass (Biogasse) Cogeneration	0	9,433.56
Biomass (Non-Biogasse) Cogeneration	0	772.05
Waste to Power	0	233.14
Waste to Energy (off-grid)	0	253.61
Total	**6,192.28**	**116,077.64**

- A policy imperative to realize carbon neutrality is to emphasize transition to renewable energy and decarbonize the energy sector.
- India aims to achieve renewable energy target of 175 GW by 2022 and 450 GW by 2030 in the total energy mix (IEA, 2020).
- Short term Goal by 2022: 175 GW (100 GW solar+60GW wind+ 10GW biomass based+5GW small hydropower plants) which is 21% of total electricity production.
- However, till Aug. 2022: Achieved 116 GW.

- At present rate of increase in renewable energy capacity, the installed annual capacity would be only 14.8 GW for the current year-2022-23.

(Source : Hindustan Times, 26.09.2022)

Land & Water Resources Management : Climate Change

Facts : Land & Water Resources-India

- **Present India Economy : $ 3.29 trillion**
- **Contribution from agriculture sector : $ 0.66 Trillion**
- **Hon PM Aimed to raise to : $ 5 Trillion (2026-27) Indian economy**
- **Contribution from agriculture sector : $ 1 Trillion**
- **Food grains Productions: 316.06 MT (2021-22).** **Higher by 1.71% (5.32 MT)**
- **Horticultural production : 329.86 MT (2021-22).** **Higher by 2.93% (9.39 MT**
- **The production can be enhanced by increasing crop acreage & yield.**
- **The crop acreage can be increased by making more land and water available for agriculture.**
- **This demands for enhancing the water productivity in every sphere of human life.**

Land & Water Resources Management : Climate Change

Facts : Land & Water Resources-India

- **The crop water productivity can be enhanced by concentrated efforts on managing more on when, how much and how to irrigate the crops.**
- **Also, due attention is required to enhance the land and water resources along with improving its health and qualities.**
- **Since the total projected demand of water will be 324 BCM more than the present level of utilizable (1123BCM) water resources, the challenge will be to (i) produce more from less water by efficient use of utilizable water resources in irrigated areas and (ii) utilize a part of grey water for agriculture production in a sustainable manner.**

Land & Water Resources Management : Climate Change

Facts : Land & Water Resources-India

- India supports 17% of the human and 15% of the livestock population of the world with only 2.4% of the land and 4% of the water resources.
- The total annual precipitation of 4000 BCM.
- The utilizable water resources of the country have been assessed as 1123 BCM, of which 690 BCM is from surface water and 433 BCM from groundwater sources.
- The ever-growing population and rising in life standard will boost the water demand in future to meet food production/domestic/industrial requirements.
- The projected total water demand of 1447 BCM in 2050 will outstrip the present level of utilizable water resources (1123BCM) out of which 1074 BCM will be for agriculture alone.
- Out of a total 140.13 Mha of sown area, India's net irrigated area is 68.38 Mha (48.7%) only while 71.74 Mha are unirrigated.

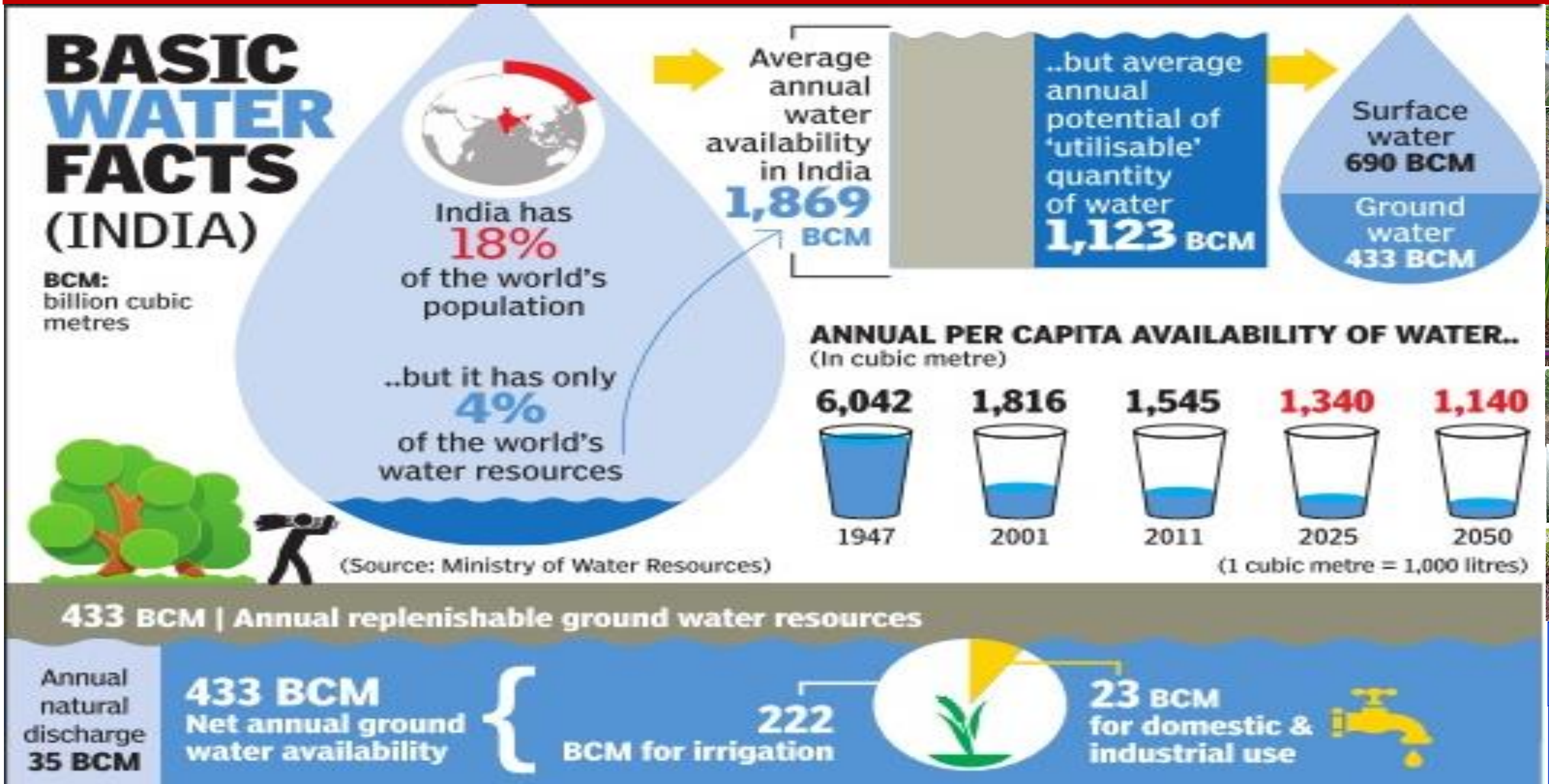
Land & Water Resources Management : Climate Change

Facts-MIS

- **This requires to promote the water use efficient Micro Irrigation Systems(MISs).**
- **The water productivity in agriculture can be enhanced through adoption of MISs.**
- **The estimated potential of micro irrigation in India is 69.5 Mha, whereas the area covered so far is only about 15.011 Mha.**
- **The penetration of micro irrigation in India is 19%, which is much lesser than many countries.**

Land & Water Resources Management : Climate Change

Facts- Status of Water Resources of India

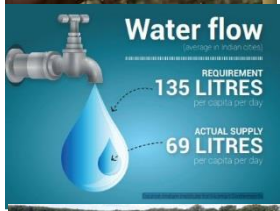


Land & Water Resources Management : Climate Change

Issues of water resources

- Spatial and temporal variation of rainfall
- Uneven spatial distribution of surface water resources
- Low potential of groundwater resources
- Poor performance of surface water resources projects.
- High evaporation of water bodies.
- Lack of awareness of importance of water
- Peoples unwillingness for the judicious utilization of water in domestic/agriculture sector
- Lack of political will for the efficient utilization of water through policy implementation
- Violations of rules/regulation/policy of industrial water/municipal waste water disposal.



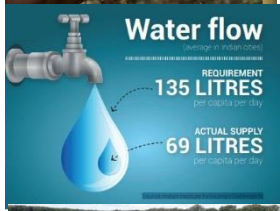


Land & Water Resources Management : Climate Change

Issues of water resources

- **Climate change: There is now mounting evidence of trends in hydrological series. Many areas face a drying and warming climate and thus potentially less water availability.**
- **Increasing vulnerability to severe weather events:**
- **Growing urban demand:**
- **Over-allocation of existing supplies:**
- **Unrestricted extractions:**
- **Land-use change:**
- **Environmental requirements: there has been an increasing emphasis on the requirement for environmental flows to maintain ecosystems such as wetland and in-stream environments.**
- **Human Ambitions and Earth's Limits**



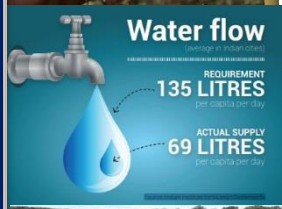


Land & Water Resources Management : Climate Change

Status of Water Resources of Gujarat

SN	Particulars	National	Gujarat State
(A)	Geographical Area (Million Ha)	311.0	19.6 (6.30%)
(B)	Available Water (Billion Cum)		
	Surface Water	690	38 (5.50 %)
	Ground Water	433	17 (3.92 %)
	Total	1123	55 (4.90 %)
(C)	Irrigation Potential (Million Ha)		
	Ultimate	139.0	6.75 (4.86 %)
	Developed	93.95	6.00 (6.38 %)
	Actual Utilized	80.06	5.01 (6.25%)
(D)	Requirement of Water for Irrigation (Billion Cum)	688	48 (6.98%)
(E)	Sector wise use of water		
	Irrigation	92%	89 %
	Drinking Supply	5%	8 %
	Industrial	3%	3 %



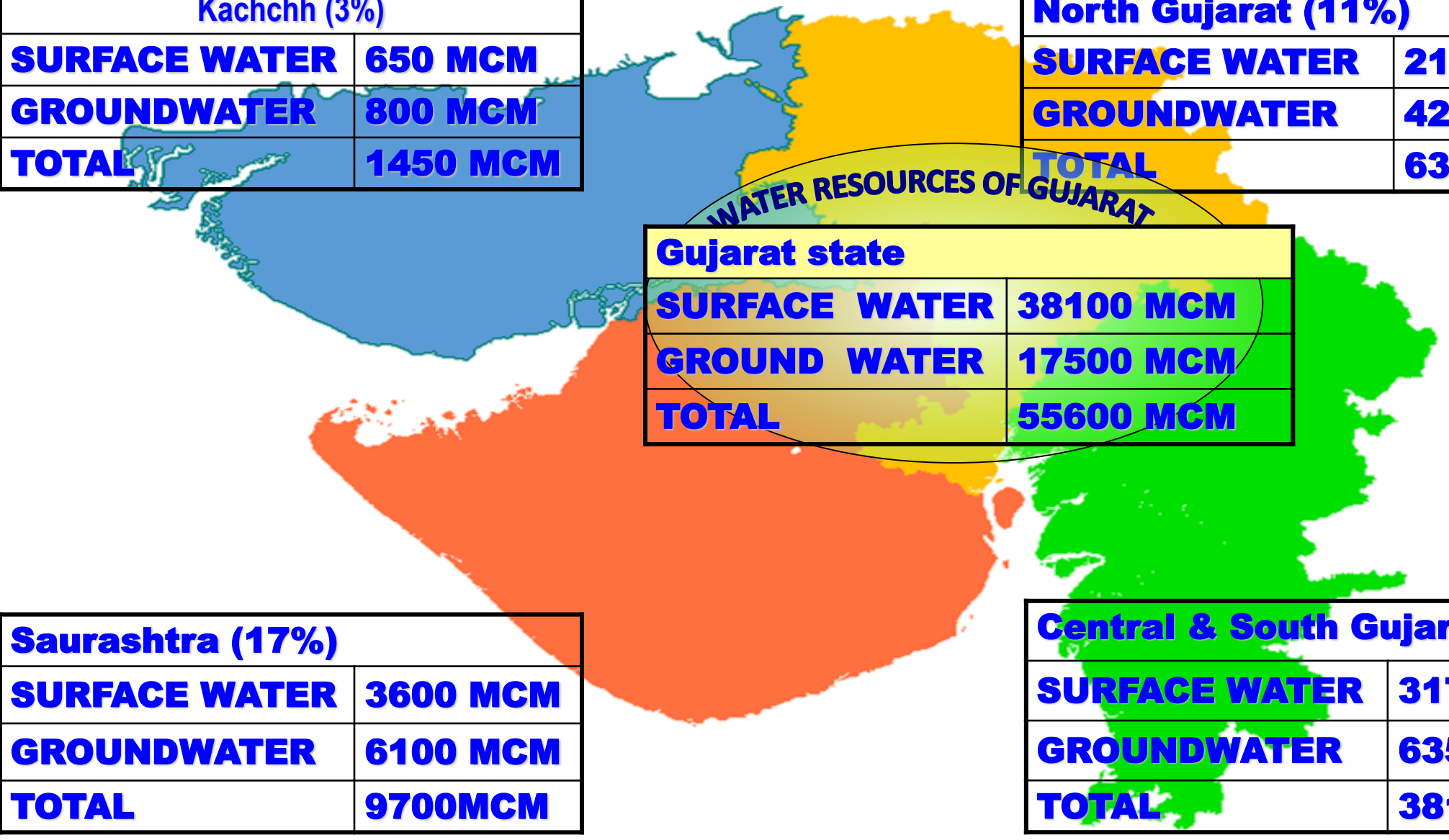


Land & Water Resources Management : Climate Change

Status of Water Resources of Gujarat

Kachchh (3%)	
SURFACE WATER	650 MCM
GROUNDWATER	800 MCM
TOTAL	1450 MCM

North Gujarat (11%)	
SURFACE WATER	2100 MCM
GROUNDWATER	4200 MCM
TOTAL	6300 MCM



Gujarat state	
SURFACE WATER	38100 MCM
GROUND WATER	17500 MCM
TOTAL	55600 MCM

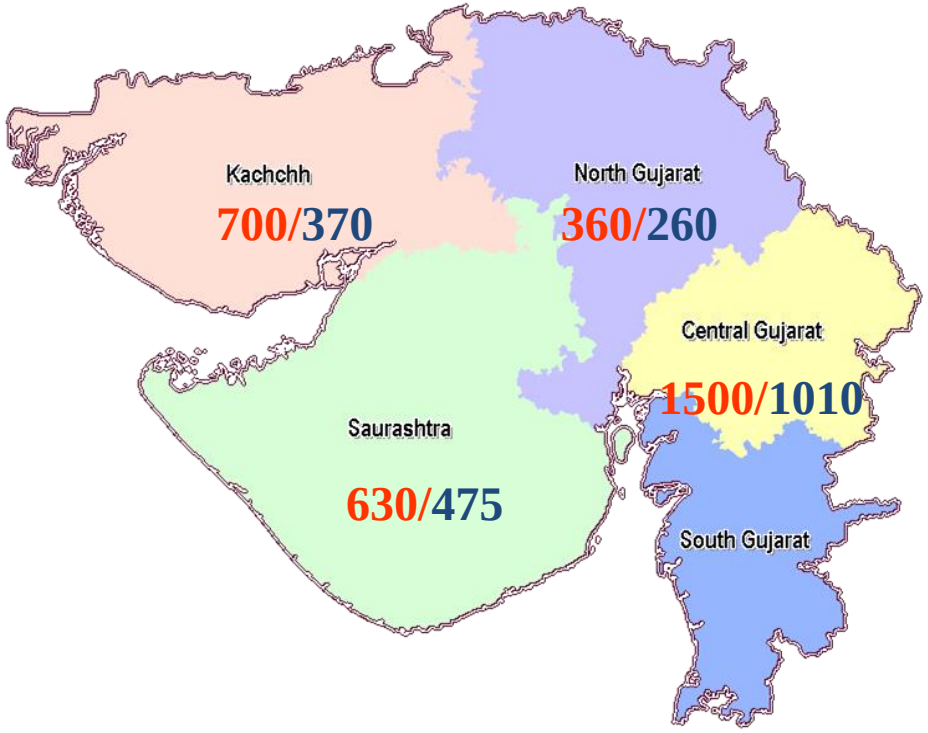
Saurashtra (17%)	
SURFACE WATER	3600 MCM
GROUNDWATER	6100 MCM
TOTAL	9700MCM

Central & South Gujarat(69%)	
SURFACE WATER	31750 MCM
GROUNDWATER	6350 MCM
TOTAL	38100 MCM

Land & Water Resources Management : Climate Change

Status of Water Resources of Gujarat

Available Per capita Water in 2011/2031 (Cum/year)



Minimum requirement of water per person = 1000 Cubic Meter/Year

- **Gujarat is a water stressed state next to Rajasthan**
- **Overall Per Capita water availability of state is 920 Cubic meter/year in 2011 (640 cum/year in 2031)**



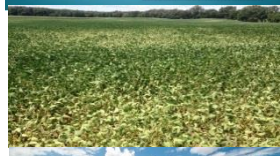



Land & Water Resources Management : Climate Change

Status of Water Resources of Gujarat

- **TOTAL GEOGRAPHICAL AREA 19.6 M ha**
- **CULTURABLE AREA 12.4 M ha**
- **Ultimate Irrigation Potential 6.75 M ha**
- **Surface Water Potential**
  - **Major & Medium Dams -1.788 M ha (92 projects)**
  - **Sardar Sarovar Project - 1.792 M ha (under progress)**
  - **Minor Irrigation projects-0.497 M ha (981 Schemes)**
  - **Water conservation Strucures-0.681 M ha**
- **Ground Water Potential -2.00 M ha (From Tube well, Shallow Wells & Community Wells**
- **Rain fed area - 5.65 M ha**



Land & Water Resources Management : Climate Change

Status of Water Resources of Gujarat

- **Cultivable area:-** 124 lakh ha.
- **Ultimate irrigation potential through the surface water:-** 39.40 lakh ha including
- **Sardar Sarovar (Narmada) Project:-** 17.92 lakh hectares
- **Groundwater:-** 25.48 lakh ha
- **Total ultimate irrigation potential through surface & ground water :-** 64.88 lakh ha
- **Rainfed area:-** 59.12 lakh ha.
- **Among total irrigated area-**
- **Canal irrigated area :-** 9.76 lakh ha (22%)
- **Area irrigated by tank water:-** 1%.
- **Area is irrigated through only groundwater:-** 77%
- **High reliability on Ground Water :- Hence, the only Agriculture sector is consuming 49% of total electricity of the state.**






Land & Water Resources Management : Climate Change

Proposed Strategies

- **In addition to largescale adoption of MIS, new paradigms in micro irrigation like :**
- **Fertigation through MIS**
- **Mulching Technologies**
- **Subsurface Irrigation**
- **Deficit Irrigation**
- **Pulse Irrigation**
- **Aerated irrigation**
- **AI and IoT based automated irrigation using real time instantaneous soil moisture and weather data from high-tech sensors**
- **MIS operation and maintenance**
- **Assuring water availabilities and critical stage wise crop water demands**
- **Irrigation water quality management**
- **Soil health management**

Want to make India a $5 trillion economy by 2024, says PM

At NITI Aayog meet, he sets up agri task force and asks States to boost growth

Thanks