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M.M. Roy
Uday Burman
Praveen-Kumar
R.K. Kaul
R.S. Tripathi
S.B. Sharma
Kundan Gawaria

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WATER DEMAND UNDER CLIMATE CHANGE SCENARIOS FOR WESTERN RAJASTHAN

R.K.Goyal, Anurag Saxena, P.C.Moharana and C.B.Pandey
Central Arid Zone Research Institute, Jodhpur - 342 003, Rajasthan
e-mail: rkgoyal24@rediffmail.com

Climate change is one of the major challenges of the recent times. The impact of climate change on natural resources around the globe has serious implications. With an economy closely tied to the natural resource base and climate sensitive sector such as water, agriculture and industries may face a major threat due to projected change in climate. Due to the exponential growth in industry, irrigation and domestic consumption, water resources are depleting day by day. Water availability will be the main issue under the climate change. There are sufficient evidences to show that the earth's temperature has risen by more than 0.5°C since 1880 and continues to rise at faster rate. Carbon dioxide is the dominant contributor to current climate change and its atmospheric concentration has increased from a pre-industrial value of 278 parts-per million (ppm) to 379 in 2005. Continued greenhouse gas emissions at or above the current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century. The degree of warming depends on the degree of emissions: If carbon dioxide concentrations were stabilized at 550 ppm - double the pre-industrial levels — the average warming expected would likely be in the range of 2-4.5°C, with the best estimate of 3°C. A warming of 0.2°C per decade is expected for each of the next two decades for a range of scenarios that do not include deliberate reductions in greenhouse gas emissions. Other greenhouse gases contribute to warming and if their combined effect were equivalent to a carbon dioxide level of 650 ppm, the global climate would "likely" warm by 3.6°C, while a level of 750 ppm would produce warming of 4.3°C.

Global warming due to greenhouse effect is expected to cause major changes in climate of some areas. The change in climate is likely to have a profound effect on hydrological cycle viz. precipitation, evapotranspiration, soil moisture. Evapotranspiration (ET) being the major component of hydrological cycle affects crop water requirement and future availability of water resources. An attempt has been made in the present study to estimate the water demand under climate change scenario for the hot arid western Rajasthan.

Agriculture continues to be the major sector of water demand in past as well as in coming future also. Out of total available surface and groundwater resources major portion (>85%) of it is being used for the agriculture. Water, as such and also as carrier of large amount of nutrients is required in a large measure for the successful growth of the plants. The metabolic activity of cells and plants is closely related to their water content. Most of water entering the plant is lost in transpiration and evaporation from the soil surface. However, failure to replace the water lost by plant in transpiration and evaporation from soil surface results in the loss of turgidity, cessation of growth and eventual death of plant from dehydration. Hence, for successful crop production evaporation demand of soil surface and transpiration demand of plant/crop must be satisfied. So to meet the evapotranspiration demand, about 90-95% of total water resources are being used. Thus, evapotranspiration demand has direct bearing on the total water demand.

Estimation of Evapotranspiration: For estimation of evapotranspiration FAO recommended Penman-Monteith model has been used. The recommended model is said to overcome shortcomings of the previous FAO Penman method and provides results that are more consistent. About 30 years (1979-

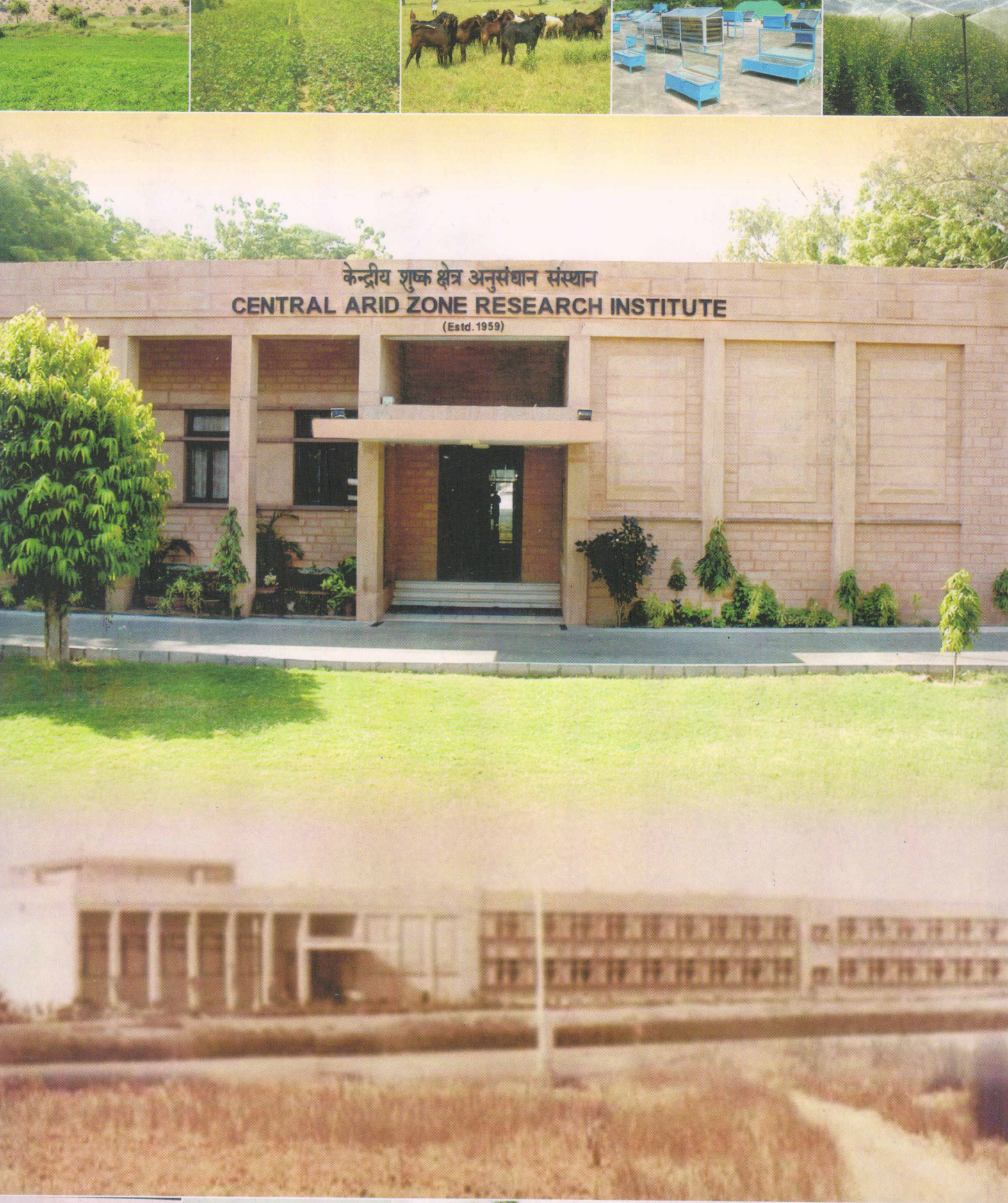
2009) climatic data of 12 districts of western Rajasthan have been used for the study. To decrease the discreteness of climatic parameters, weekly averages over different years were used for estimation of evapotranspiration. Weekly reference evapotranspiration was calculated using above described Penman-Monteith equation. The normal average annual evapotranspiration of the western Rajasthan varied from minimum of 1502 mm for Nagaur to maximum of 2177.2 mm for Barmer.

Water demand under climate change: The most visible and likely threat from climatic changes is by increase in evaporative losses and water demands caused by higher temperature. Globally evapotranspiration trends are projected for +5% to +10% increases due to increased in temperature by +2 to +5°C. It is reported that global evaporation changes by 3% when temperature changes by 1°Celsius. Enhanced evapotranspiration would be primarily a consequence of higher air and land surface temperature. Even in tropics, where temperature increase is expected to be smaller than elsewhere, the increased rate of loss of moisture from plants and soil could be considerable. Some studies on effects of greenhouse warming on the water resources of the Indian subcontinent suggested a rise in annual mean surface temperature of 2.0-3.5°C over the Indian subcontinent by the year 2090. According to the study warming would be most pronounced over the northwestern India. In the present study evapotranspiration demand has been re-estimated for climate changed scenario of increase in temperature by 1° and 2°C keeping other climatic parameters constants.

As small as 1°C increase in normal temperature will enhance the evapotranspiration from minimum of 35 mm for Ganganagar to highest of 96 mm for Jaisalmer district. Enhanced evapotranspiration would be primarily a consequence of higher air and land surface temperature. The increase in evapotranspiration demand will have a direct bearing on total water demand for irrigation. The increase in temperature by 1°C will cause an additional annual water demand of 1570.9 mcm for the entire western Rajasthan based on net irrigated area of 3164512 ha. The total available utilizable ground water for western Rajasthan is 3516.9 mcm and increase of 1% in temperature will put additional stress of 44% on existing groundwater resources based on present landuse pattern.

Since western Rajasthan is not blessed with good perennial river systems, so any increase in water demand require careful planning for future water resources development. More emphasis is needed to develop technologies for reducing water losses in reservoirs, conservation of rainwater and development of such crop varieties that require less water. So it is high time for the planners/users/water resources managers to think in term of expected water demand due to global warming and its likely effect on water resources of Rajasthan. The availability of water has direct bearing on the type of crops to be grown and will determine the economy of the state.

Conclusion: Water will continue to be a vital resource in arid and semi-arid regions of the world, and conflict over its access and possession are likely to worsen in water stressed regions such as Rajasthan. Even without changes in other parameters water availability can be decreased by 44% or more simply owing to temperature increase of 1°C –well within the range of expected change. Therefore, a relatively small decrease in water availability can readily produce drought conditions. Increase in risk and intensity of drought, especially in drought prone regions like Rajasthan; represent potentially the most serious impact of climate change on agriculture both at a regional and global level. These effects are independent of the increased demands from both human users and natural ecosystem that will occur at the same time. A precautionary approach to the problem of global warming is warranted on the basis of its potential impact and the scale of the response that is necessary if that impact is to be avoided. On one hand intensive and global measures are needed to curb the concentration of greenhouse gases produced by various human activities and on other hand effective measures are needed to increase water use efficiency and reduce losses.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