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Impact of Solar Activity on Hydrological Cycle of the Himalayan and Indian Peninsula Rivers

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Abstract: In recent times, several studies around the globe show that some rivers are losing water, in some cases because of the effects of climate change. At the same time some rivers are increasing water. This mass transfer of water corresponds to the hydrological cycle. We observe, due to climate change a redistribution of water on the earth surface. Over the period 1850 to 1996 was observed steady increase of sunspots on the Sun. The same period was called as the global warming period. The purpose of this study is to identify contribution of the Sun on trend of river runoffs.

Key words: river runoff, solar activity, sunspot number, hydrological cycle, air temperature

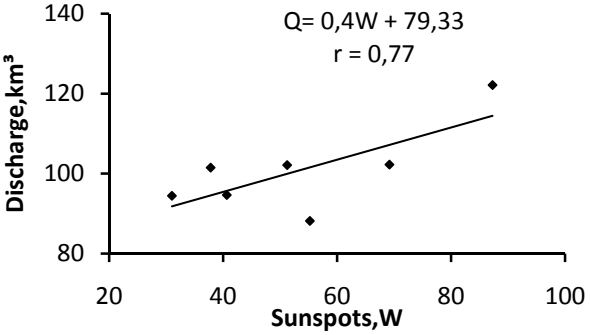
1. Introduction

Over the all geological history — 4 billion years, the Earth's climate has changed many times. The movement of the Earth's plates and orbital forcing (the Milankovitch cycles) are believed to explain climate changes that occur over tens or hundreds of millions of years. Both of these processes involve the position of the sun relative to the earth's surface.

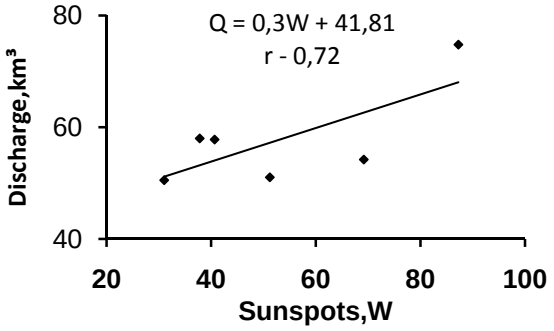
The source of the virtually all energy in the water cycle and in climate system is radiation from the Sun. In fact 99.97% of energy budget of the earth arrives from the Sun [1]. The sun's heat and light energy are warms the land surface and oceans and radiates heat back into the air above. It is believed that increase of solar activity leads to a rise in atmospheric temperature, intensification of hydrological cycle and consequently to an increase in river flow.

2. Indian Peninsula Rivers

The climate of Hindustan Peninsula is subequatorial monsoon. The rivers fed by rain. The Himalayas act as a barrier to the frigid katabatic winds flowing down from Central Asia.



The Godavary River over the period 1902-1976



The Krishna River over the period 1902-1964

Fig. 1 Relationships of River Discharges in Dependence from Solar Activity over A Period of Many Years. Where: Q: River Discharge in km³, W: Sunspots Number, r: Coefficient of Correlation

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The Himalayas are a major barrier for the natural flow of the southwest monsoon (5000 m a.s.l.). This barrier makes river regime of Indian Peninsula different from Himalayan Rivers. There is a significant positive relationship between solar activity and river annual flow runoff the rivers Krishna and Godavari. Long-term trend in river flows coincide to phase of increase of solar activity.

The similar trend was found in the long-term increase in temperature of all Indian subcontinents, Fig. 2. Temperature rise of weather stations Mumbai, Nagpur, Madras, Bangalore and Hyderabad over the period 1890-1996 corresponds to more active Sun. Correlation coefficient varies from 0.78 and 0.88. This positive relationship is actually conventional. More sunspots mean increased solar activity, more energy makes its way to Earth, and our planet will warm, warm air increases the evaporation process, and leads to intensification of hydrological cycle.

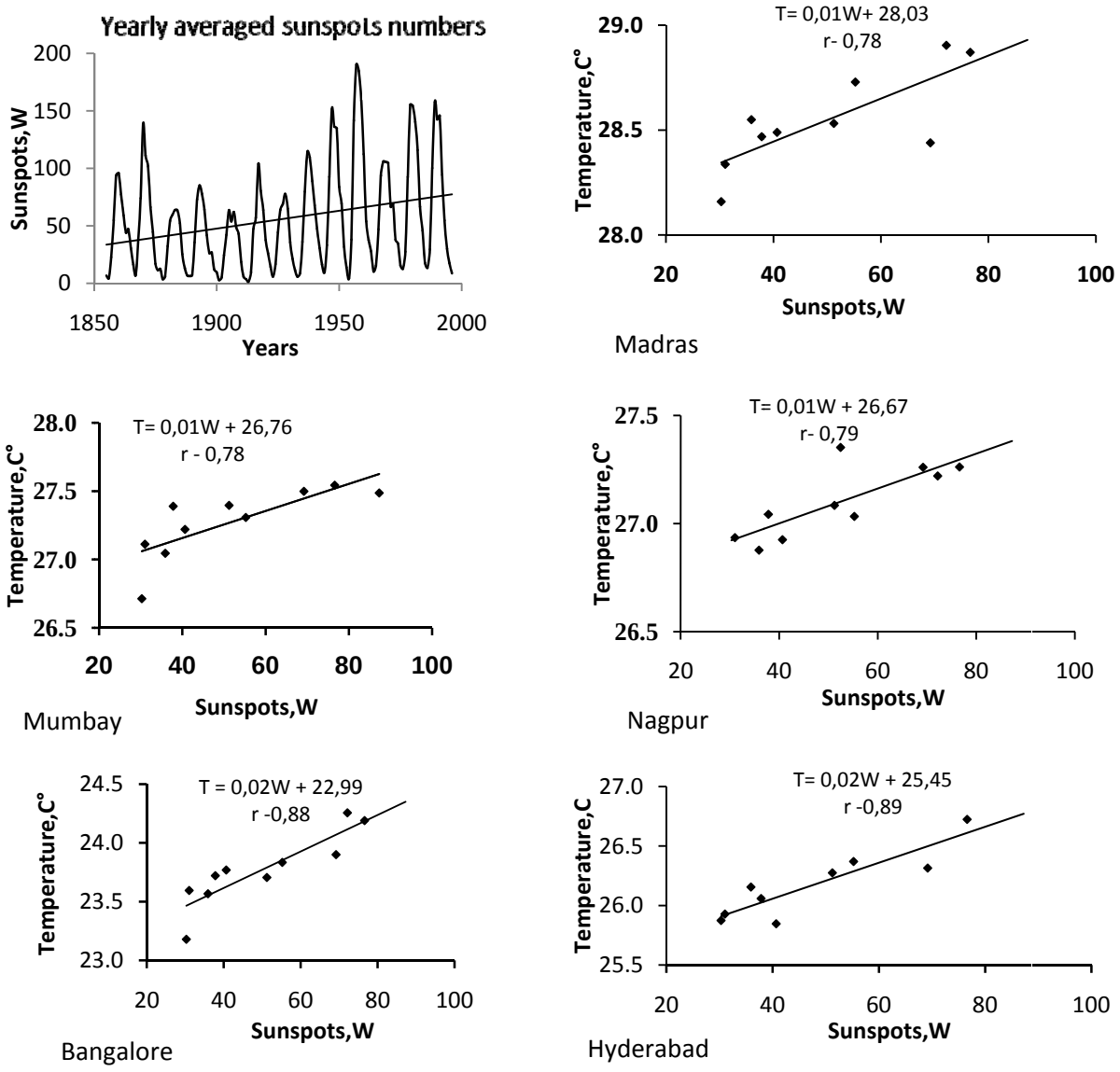


Fig. 2 Relationships of Air Temperature in Dependence from Solar Activity over a Period of 1890-1996 in Indian Peninsula. Where: T: Air Temperature in C°, W: Sunspots Number, r: Coefficient of Correlation.

3. Himalayan Rivers

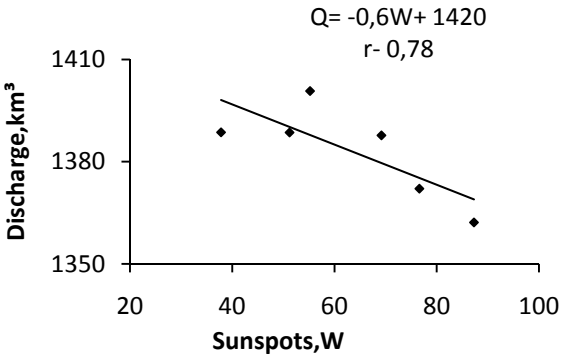
The east west ranges of the Himalayas have southern slopes which will receive comparatively more solar radiation thereby hastening the melting process. On the northern slopes the snow will melt later. The mountain barrier must have disrupted west-to-east flow of winds and caused northward displacement of high pressure centre that commonly lies near the 30°–35° latitudes, so that the low-pressure centre moved over northern India in summer. Rivers Ganges and Yangtze are perennial as they get water from the rainfall as well as the melting of ice. The contribution of snow and glacier- melt runoff to Himalayan Rivers is significant. The steady increase in the numbers of sunspots reduces the Yangtze (station Hankou) and Ganges rivers runoff.

In accordance with scientific reports by last year, the total area of glaciers had decreased to 1,051 square kilometers from 1,283 square kilometers in 1971 in the source area of the Yangtze River. Nearly 1 billion cubic meters of glaciers were melting yearly. This corresponds with long term decrease of the Yangtze River discharge over the 110 year, however over the period 1878-1933 occurred about two times more intensive decrease in runoff.

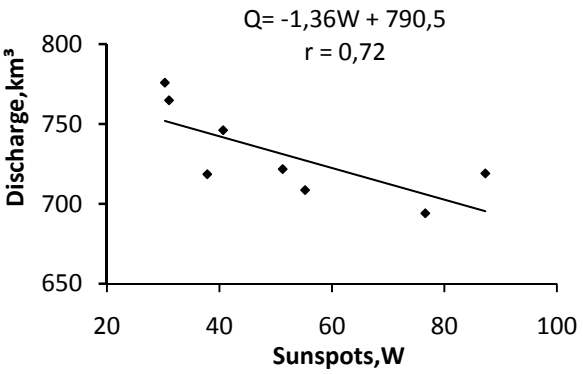
The major floods were the 1954 Yangtze River Floods and solar cycle 18 over the period of 1944-1954 was withdrawal from calculation in Fig. 3, because of unknown source of this flooding.

The Tibetan Plateau perhaps is the best example of a rain shadow. Rain does not make it past the Himalayas, leading to an arid climate on the leeward side of the mountain range.

Most meteorological stations on the Tibetan Plateau were not established until the early 1950s, with the exception of a few observational records that were collected before the 1930s. Therefore, because for detecting of the long term trend in temperature change as rule it is necessary more than 50 years observations, we calculated stations located in the peripherals part of the Tibetan Plateau, Fig. 4. The time period considered is mainly from 1933 to 1996 [2].



Ganges River over the period 1923-1986



Yangtze River over the period 1878-1986

Fig. 3 Relationships of River Discharges in Dependence from Solar Activity over A Period of Many Years. Where: Q: River Discharge in km³, W: Sunspots Number, r: Coefficient of Correlation.

4. Discussions

Hydrologic cycle is the continuous movement of water on, above, and below the surface of the Earth. The main source of energy in the water cycle is the sun. The total amount of water that is on Earth is constant and never changes. Climate change leads to redistribution of water on the surface of the Earth. In this way the orographic effect is a change in atmospheric conditions caused by a change in elevation, primarily due to mountains. Intensification of atmospheric circulation due to climate change makes the water cycle more intensive. The mountain ranges intercept evaporated water mass transfer. The climate

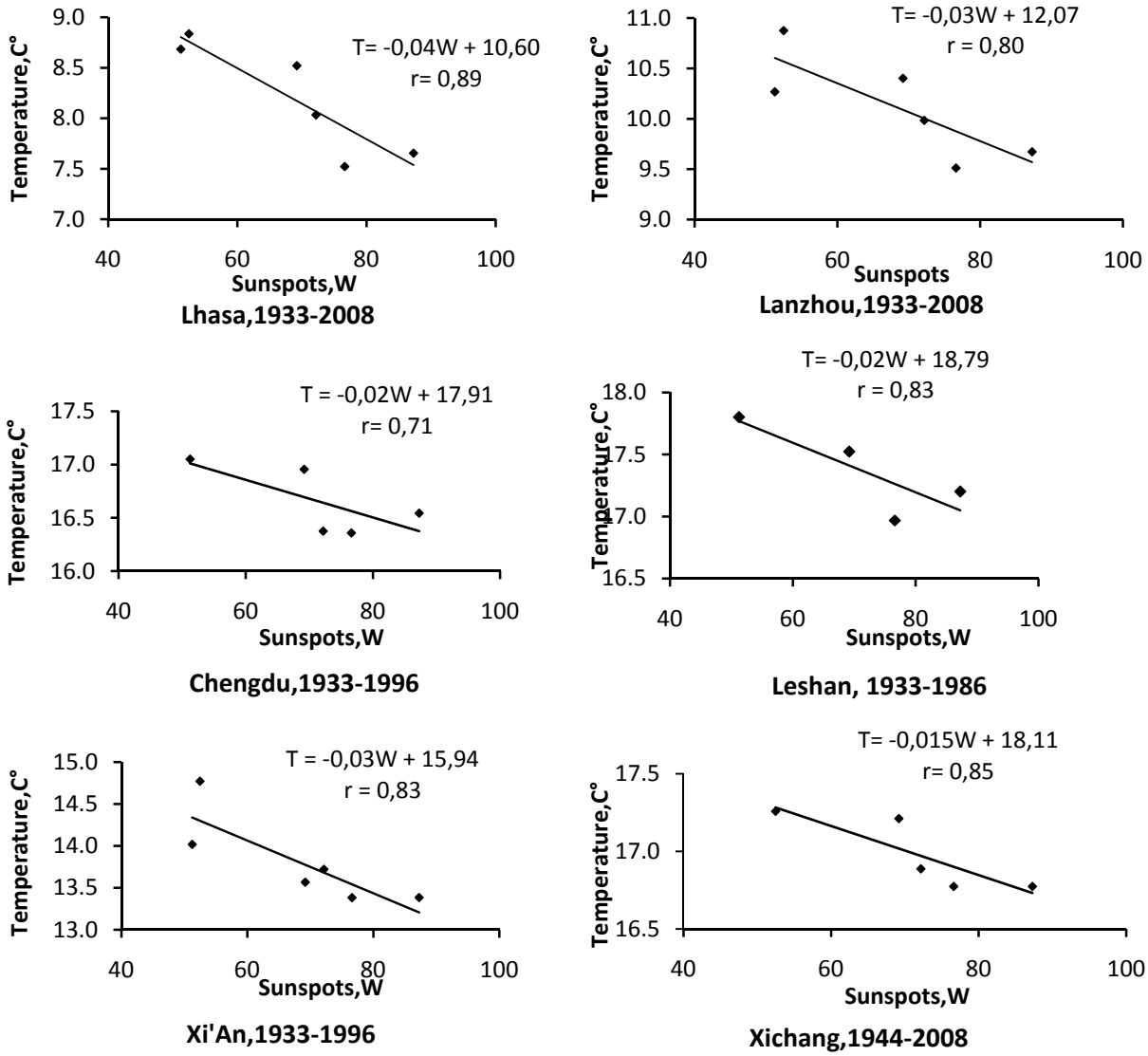


Fig. 4 Relationships of Air Temperature of Different Weather Stations from Solar Activity at the Tibetan Plateau over a Period of Many Years

on the leeward side of a mountain differs from that on the windward side mostly in the amount of rainfall.

In accordance with NASA forecasting the next two solar cycles will be below average in intensity — averaged sunspot numbers W = 35 for the solar cycle 24 (2008-2018) and for the solar cycle 25 (2018-2029) less than W = 35. This actually will lead to a decrease of the temperature on 1-1, 5°C in the both averaged solar cycles. In catchment area of the rivers Yangtze, Ganges will be more floods and in watersheds area of the rivers Godavari and Krishna — discharges will be lower.

The source of the data: The Global Runoff Data Centre. Koblenz, Germany, NASA, GISS Surface Temperature Analysis.

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