SESSION-7 :

CLIMATE CHANGE, RAINFALL ANALYSIS, INSTRUMENTATION NEEDS

14th National Symposium on Hydrology with focal theme on "Management of Water Resources under Drought Situation", 21-22 December, 2010, Organized by National Institute of Hydrology, Roorkee and Malaviya National Institute of Technology, Jaipur at Jaipur, Rajasthan

METHODOLOGY TO ASSESS THE GROUNDWATER RECHARGE AND FLOW SIMULATION FOR CLIMATE CHANGE SCENARIOS

Surjeet Singh, N.C. Ghosh, C. P. Kumar
National Institute of Hydrology, Roorkee – 247667 (Uttarakhand)

ABSTRACT

Climate change is one among the most vulnerable issues in present time. The most noticeable impacts of climate change could be fluctuations in surface water levels and quality, but the greatest concern of water managers and government is the potential decrease and quality of groundwater supplies, as it is the main available potable water supply source for human consumption and irrigation of agriculture produce worldwide. Because groundwater aquifers are recharged mainly by precipitation or through interaction with surface water bodies, the direct influence of climate change on precipitation and surface water ultimately affects groundwater systems. This paper discusses the climate change scenario for groundwater in India and presents a methodology for assessment of groundwater recharge and groundwater flow simulation to study the impact of climate change. Groundwater resources are related to climate change through the direct interaction with surface water resources, such as lakes and rivers, and indirectly through the recharge process. The direct effect of climate change on groundwater resources depends upon the change in the volume and distribution of groundwater recharge. Therefore, quantifying the impact of climate change on groundwater resources requires not only reliable forecasting of changes in the major climatic variables, but also accurate estimation of groundwater recharge.

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SOUTH ASIA; CLIMATE CHANGE AND VULNERABILITY

Neeraj Kumar Bhatnagar, Anil Kumar Lohani, Rakesh Kumar
National Institute of Hydrology, Roorkee

ABSTRACT

Warming of the climate system over the past century is very clear. It is very likely that most of the global warming since the mid-20th century is due to increases in greenhouse gases. By the middle of the 21st century, annual average river runoff and water availability are projected to increase as a result of climate change at high latitudes and in some wet tropical areas, and decrease over some dry regions at mid-latitudes and in the dry tropics. Many semi-arid and arid areas (e.g., the Mediterranean Basin, western USA, southern Africa and northeastern Brazil) are particularly exposed to the impacts of climate change and are projected to suffer a decrease of water resources due to climate change.

Observed warming over several decades has been linked to changes in the large-scale hydrological cycle such as: increasing atmospheric water vapour content; changing precipitation patterns, intensity and extremes; reduced snow cover and widespread melting of ice; and changes in soil moisture and runoff. Precipitation changes show substantial spatial and inter-decadal variability. Over the 20th century, precipitation has mostly increased over land in high northern latitudes, while decreases have dominated from 10°S to 30°N since the 1970s. The frequency of heavy precipitation events (or proportion of total rainfall from heavy falls) has increased over most areas. Globally, the area of land classified as very dry has become more than doubled since the 1970s. There have been significant decreases in water storage in mountain glaciers and Northern Hemisphere snow cover. Shifts in the amplitude and timing of runoff in glacier- and snowmelt-fed rivers, and in ice-related phenomena in rivers and lakes, have been observed.

The climate is vastly complex and strongly influenced by many factors other than greenhouse gas concentrations. This makes it extremely difficult to link any climatic events or characteristics to a single cause. The earth's climate has changed over time and throughout the earth's history and there have been periods of glaciations followed by warming trends in which the glaciers retreated toward higher altitudes and latitudes.

The South Asian Region is already marked by climate variability and a high incidence of natural disasters. South Asia's climate is as diverse as its landscapes. The region's geographic expanse covers a variety of climate zones and ecosystems ranging from lush tropical forests to arid deserts and high altitude forests and lakes. Climate risks in the region reflect these varying conditions with regular droughts, floods, wind storms and tropical cyclones. The region shares common geological formations and river basins; natural hazards frequently transcend national boundaries. With climate change the frequency and incidence of natural disasters is projected to increase.

The impacts of climate change in the form of higher temperatures, increasing variability in precipitation, and more extreme weather events are already felt in South Asian region. It has been projected that these impacts of climate change will further intensify. By 2050, the South Asia's population is likely to exceed 2.2 billion from the current level of 1.5 billion. Even small climate shocks can cause irreversible losses and tip a large number of people into destitution.

The monsoon has the most significant climate impact on the South Asian region's economy. It carries over 70 percent of South Asia's annual precipitation in only four month period. Also, The Himalayas have a significant influence on the climate and economy of the region. Urbanization poses an additional challenge in the region. It is reported by various researchers that South Asian region is highly sensitive to the consequences of climate change due to combined effect of high population densities, large concentration of poverty and climate variability.

Keeping in view the above discussions, regional scenario of South Asia with respect to the climate change and vulnerability has been described by the authors in this review paper.

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SHORT DURATION RAINFALL ANALYSIS FOR PUNPUN BASIN

N. G. Pandey, B. Chakravorty, R. Venkataramana, P. Mani
Centre for Flood Management Studies
National Institute of Hydrology, Patna-801 505

ABSTRACT

Analysis of short duration rainfall is essential for estimation of floods for small catchments. The time of concentration for such catchments may even range for few hours. For small catchments discharge data are rarely available, which are required for design of small dams, culverts, drop spillways etc. In the absence of the long term stream flow data, flood estimation may be carried out by estimating the design rainfall excess and convoluting it with the unit hydrograph (UH) ordinates of the catchment.

The present study deals with analysis of short duration rainfall for Punpun basin of Bihar. The analyses have been used to estimate the design storms which may be used for estimation of design flood of a small catchment. The rainfall data of 11 raingauge stations located in the basin has been used. Thiessen polygon method is used for computing the average areal rainfall for the study area. Depth-area-duration (DAD) curves have been prepared for the Punpun basin selecting the severemost storm. Depth-duration-frequency (DDF) curves have been prepared using L-moments based general extreme value (GEV) distribution. DDF curves give the design storm depth at various return periods for a specified duration.

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STATISTICAL PROCEDURES FOR ANALYSIS OF HYDROLOGICAL DATA

Shobha Ram
National Institute of Hydrology Roorkee

ABSTRACT

Frequency analysis is one of the earliest and most frequently used applications of statistics in hydrology. Moreover, frequency distributions are used as models for most of the statistic works. In this paper, frequency analysis of distributions for discrete as well as continuous variables is discussed. Multivariate distributions are also discussed. The frequency analysis includes mean, mode, mean deviation, variance, standard deviation and coefficient of variation. Two types of distributions namely discrete and continuous distributions are considered. The discrete distribution includes binomial and poisson distribution and continuous distribution includes uniform and normal distributions. The density and distribution functions are also discussed. Multivariate distributions include bivariate normal distribution and discrete bivariate distribution.

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TIME SERIES ANALYSIS OF SOUTH WEST MONSOON RAINFALL

Manohar Arora, Naresh Kumar, Rakesh Kumar
National Institute of Hydrology, Roorkee 247 667

ABSTRACT

The southwestern summer monsoons occur from June through September. The Thar Desert and adjoining areas of the northern and central Indian Subcontinent heats up considerably during the hot summers, which causes a low pressure area over the northern and central Indian subcontinent. To fill this void, the moisture-laden winds from the Indian Ocean rush in to the subcontinent. These winds, rich in moisture, are drawn towards the Himalayas, creating winds blowing storm clouds towards the subcontinent. The Himalayas act like a high wall, blocking the winds from passing into Central Asia, thus forcing them to rise. With the gain in altitude of the clouds, the temperature drops and precipitation occurs. The monsoon accounts for 80% of the rainfall in India. Agriculture is heavily dependent on the rains.

Time series analysis on the data set of the total monsoon rainfall over India for the period 1901 to 2009 (109 years) has been performed. The trend value from this time series was determined by moving average method. It was found that the monsoon rainfall is showing slightly negative trend (-ve slope of 0.18). The seasonality component was deduced from the de-trended series considering one set up to 1970 and another up to 2009 was further categorized in two categories. The residual were also determined and it is observed that seasonally adjusted series follows the same pattern as the original series.

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INSTRUMENTATION NEEDS FOR DATA COLLECTION NETWORKS IN INDIA

V. C. Goyal
Research Coordination & Management Unit,
National Institute of Hydrology
Roorkee-247667, India

ABSTRACT

Sound and sustainable development of water resources requires scientific inputs in assessing the available natural resources, and their proper management. The collection and continuous supply of reliable and timely data, as well as the establishment and maintenance of historical data series, are basic requirements for acquiring information for planning and management purposes. This, in turn, requires reliable data on desired spatial and temporal scales to improve our ability to predict watershed response to various management practices under climatic variability and in the presence of natural variability. It is essential to more efficiently observe, measure, and understand the attributes and interactions of a variety of watershed areas. This improved capability requires enhancement of our experimental and observational technologies. There is also an increasing need to expand the number of hydrologic parameters to be sensed, improve the reliability of existing sensors, and improve the efficiency of the stations that provide data to the agencies involved in the operational hydrology.

In large parts of the world, including India, the collection and dissemination of water-related information have been in serious decline in recent years. When stations malfunction, they are closed because there are no resources for repair or spare parts. Essential activities such as station calibration are neglected, because of a lack of money for field travel. Computer archives are maintained on obsolete hardware/software or have never existed, and paper records are fast deteriorating. The net result is that the records have long gaps and are of unknown quality. This drastically reduces their value for engineering design, assessment of trends in the resource, or informed planning and resource management.

We are in an era where both types of instruments (old and new-generation) are in use. The traditional hydro-meteorological measurement systems have served hydrologists well over the years, providing them with a unique capability to measure the various variables. A serious limitation of the old instruments is that, being manual and mechanical, they need operators and this restricts their use to those parts of the land that are inhabited. Most mountainous, desert, polar and forested areas are, as a consequence, almost completely blank on the data map. To address the limitations of conventional systems, instruments based on advanced technologies have been developed, such as those using sensors incorporating new technologies and microprocessor-based data collection and recording subsystems. It is also possible to use telemetry communication systems with these new instruments for transmission and storage of data from remote sites. The resolution, accuracy and frequency of measurement have

greatly improved with the new-generation instruments. The paper outlines various R&D issues concerned with the instrumentation needs for improvement of the water resources monitoring activities in the country, especially with a view to address the concerns expressed in the National Water Mission.