SYNOPSIS

Water is the most complex natural resource demanding a comprehensive understanding of its inherent features in occurrence and distribution for an integrated planning aimed at an optimum national development for agriculture, health, industry, power, transport and number of other such activities. Water acquires more significance when we talk about arid regions due to its meagerness.

Kutch is an arid region with low rainfall and scarce water resources. Inspite of having the largest geographical area amongst all districts of Gujarat and the maximum number of rivers in a single district for Gujarat, it has the least water potential. Various other historical, geological and political reasons make Kutch a region dependent on its own resources. There are very limited options to draw upon any external resources. The arid conditions of the region allow limited supplies of water and there is a need to provide for the growing demand. The governments' efforts in the last four decades in the development of Kutch water resources has enabled it to bring mere 2 % land under intensive agricultural development, against 14 % of defined agriculture land of the district. This has proved beyond any doubt that the solution to this intricate problem lies with the emphasis on local area resource development. With scanty and erratic rainfall pattern, scarcity of water and excessive exploitation of ground water, Kutch is an ideal region for study of water resources for future planning and management.

The Kutch district has a geographical area of 45652 km^2 which is about 23.29 % of the total area of Gujarat. It also has 81 rivers or streams which is the highest number for any district in Gujarat. If all the small streams are also included, the number of streams goes up to 199. All the rivers are seasonal giving flashy runoff for short durations. Inspite of having 20 medium irrigation schemes, 165 minor irrigation schemes, 939 checkdams (till June 2008) and number of other micro structures, sufficient quantity of surface water is not available for domestic as well as irrigation purposes.

The Kutch district stretches roughly from 22°44′11″ to 24°41′25″ north latitudes and 68°09′46″ and 71°54′47″ east longitudes. It is the border district of India and forms the northwestern region of India as well as the Gujarat state. It has a very large portion of its area (about 26000 km^2) covered by a desert (known as Great Rann and Little Rann). It has a grass land of 2144 km^2 the largest in Asia. The district has a coastline of 322 km, which is about one-fifth of the total coastline of the state. It is bounded on the north and north-west by Sindh (Pakistan), on the north-east by Rajasthan, on the east by the districts of Banaskantha and Mehsana, on the south-east by Surendranagar district, on the south by the Gulf of Kutch and the Rajkot district and on the south-west and west by the Arabian Sea. Administratively, the district consists of nine talukas namely Anjar, Bhachau, Bhuj, Lakhpat, Mandvi, Mundra, Nakhatrana, Naliya and Rapar. The district has its headquarters at Bhuj.

With the above circumstances, it was a challenging job for developing the relationship between rainfall, runoff, surface and groundwater potential for Kutch. A long span of

nearly 8 years has been spent for collection of the huge data, its analysis and development of the correlations. However, at the end of this study, appreciable results have been obtained which can be used in planning and management of water resources in the region in future by various agencies associated with it.

For the purpose of this study, 130 year annual rainfall data from 1878 to 2007, 19 year daily rainfall data from 1989 to 2007 and 19 year data from 1989 to 2007 for pre-monsoon and post monsoon water level fluctuation for 208 wells was collected and analysed.

For the 130 year rainfall analysis, the values for mean, median, minimum, maximum, variance, standard deviation and standard error of estimation were found out. The probabilities for occurrence for various ranges of depths of rainfall were found out. Analysis was done to obtain the results for the number of drought years, number of rainfall deficit years, number of years with normal rainfall, number of years with above average rainfall and number of years with surplus rainfall for the span of 130 years.

As the daily rainfall data was obtained for a period of 19 years, separate analysis of rainfall was carried out for the 19 year data for annual and monthly values for obtaining the values for mean, median, minimum, maximum, variance, standard deviation and standard error of estimation. Figures were developed for visual distribution of the annual and monthly rainfall pattern for all the talukas of the region.

The runoff for all the watersheds has been calculated using daily rainfall data for the period of 1989 to 2007 using the Soil Conservation Service model (USDA-SCS, 1972). The landuse map was generated using the images derived from Landsat Thematic Mapper (TM) data at 90 m resolution for November 2009 using the photo-interpretation technique. Boundaries of prominent landforms were delineated and mapped and their morphological features, tonal variations and landuse / land cover were interpreted and demarcated. Runoff Curve Numbers (CN) values were determined using the hydrological soil groups (A to D), hydrological cover conditions (poor, fair and good) and five day antecedent rainfall values. The available soil map for the district was used to find the Hydrologic Response Units (HRU) for the region. As there were more than one curve numbers for each catchment, the weighted curve numbers were found out and considered for the estimation of daily runoff. The daily runoff obtained was summed up to find out the annual runoff. The analysis was done for the annual and monthly runoff values to obtain mean, median, minimum, maximum, variance, standard deviation and standard error of estimation. Figures were developed for visual distribution of the annual and monthly runoff pattern for all the talukas of the region

The analysis for the groundwater potential was done for all the talukas. The groundwater levels for a total of 208 wells in all for 19 years have been plotted to obtain the average pre-monsoon and post-monsoon water levels for each taluka for all the years. To judge the groundwater potential, figures for pre-monsoon and post-monsoon water tables have been developed for visual analysis. The data for the number of wells, rainfall pattern, the total agricultural area and the total geographical area was used for analysis and the equation for obtaining the draft in mm for the district was developed using the technique

of multiple regression. The values for groundwater recharge due to rainfall and the groundwater recharge due to surface storage have been calculated and the total groundwater recharge is obtained as the sum of the two values. The analysis was done to obtain mean, median, minimum, maximum, variance, standard deviation and standard error of estimation

After analysis of rainfall data, runoff data and data for groundwater table fluctuations and recharge, inter relations were developed between rainfall and runoff for annual values as well as monthly values for all the talukas of the region. Similarly relations for rainfall and groundwater recharge were obtained for all the talukas of the region. These relations have been developed with 95% confidence level and therefore can be very useful for the region.

Overall, during the course of this study, a total of 291 figures and 57 graphs have been developed and 75 tables have been prepared.

The study shows that the average annual rainfall for Kutch ranges between 350 to 400 mm. The rainfall increases from north to south and east to west for the region. The runoff ranges from 15 to 35 % of the rainfall values. The values of runoff are higher for the south flowing catchments. The groundwater recharge due to rainfall ranges between 5 to 35 % of the rainfall values and that due to surface storage ranges between 5 to 15 %. The equation developed for estimation of groundwater draft shows that the rainfall pattern, the number of wells and the agricultural as well as the total area plays a very significant role in the value of the draft.

The study will be beneficial to all those who are associated in the field of water resources management of Kutch region for estimating the values of runoff and groundwater recharge based on the values of rainfall