iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3569

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Development of Rain Gauge Station in SGI Campus

Anuradha Kamble[1], Anappa Bhanuse[2], Shridhar Gaikwad[3] Seema S Shiyekar[4]
[1, 2, 3, 4] Department of Civil Engineering, Sanjay Ghodawat Institutes, Atigre

Abstract: Hydrology study of water and its properties, including its distribution and movement in and through the land areas of the earth. The hydrologic cycle consists of the passage of water from the oceans into the atmosphere by evaporation and transpiration (or evapotranspiration), onto the lands, over and under the lands as runoff and infiltration, and back to the oceans. Hydrology is principally concerned with the part of the cycle after the precipitation of water onto the land and before its return to the oceans; thus meteorology and oceanography are closely related to hydrology. The study area which located in the survey of India Toposheet Nos.47L/5 & 47L/6 is present in the Kolhapur district of Maharashtra which also uses the LISS-III satellite image. The data base is created using various techniques. The maps which are prepared by Geo referencing and digitization from SOI Toposheet and LISS-III satellite image using QGIS2.6.1 – Brighton software. The Survey of India Toposheet scale 1:50,000 and LISS-III satellite image are used for preparation of the slope, catchment area and contour. The main aim of the proposed study is to establish proper rain gauge station as there is no rain gauge station in the nearby vicinity. As SGI campus is located in the hilly region it is appropriate sit for establishment of rain gauge. But to do this it is important to carry out survey of entire campus for proper location of gauge station this survey. This is carried out by using QGIS software, counters are plotted and fixed the location of the gauge station. The proper type is suggested as Tipping bucket. Then by available rainfall data by using Thiessen polygon method the attempt is made to calculate precipitation at proposed gauge possibly may get collect.
Keywords: Hydrology, Rain gauge station, QGIS, Tipping bucket

I. INTRODUCTION

The accurate estimation of the spatial rainfall distribution requires a dense network of instruments, which entails large installation and operational costs. It is thus necessary to optimize the number of rainfall stations and estimate point precipitation at unrecorded locations from existing data. Establishment of a spatial representative rainfall stations from the entire existing network in the study area (i.e., rainfall-data optimization); and to use of multivariate geostatistical algorithm for incorporating relatively cheaper hydrological data into the spatial prediction of rainfall. Evaluate area rainfall quantity or area weighted rainfall (AWR), Thiessen Polygon is one of the widely used technique and important method. Its calculation method is fast, simple and some what accurate. With this method, the calculation of rainfall is simple, in a way that only the station's rainfall amount and the calculated station weight, area of the influence of each station (also called Theissen Constant or Area Factor) are required. Thiessen Polygon method is a standard method for computing mean areal precipitation (MAP) for the area having more or less homogeneous topographic as well as meteorological features. Optimal Rain Gauge Network Design and Spatial Precipitation Mapping Based on Geostatistical Analysis from Colocated Elevation and Humidity[1] is published by in International Journal of Environmental Science and Development, Vol. 3, No. 2, by Aksara Putthividhya and Kenji Tanaka, Member IACSIT and they concluded that establishment of a spatial representative rainfall stations from the entire existing network in the study area (i.e., rainfall-data optimization); and use of multivariate geostatistical algorithm for incorporating relatively cheaper hydrological data into the spatial prediction of rainfall**.** An Automated Rainfall Monitoring System[2]is published by S.P.K.A Gunawardena, B.M.D Rangana, M.M Siriwardena, Prof Dileeka Dias, Dr Ashok Peries Department of Electronic and Telecommunication Engineering University of Moratuwa. The paper describes a system to automate the monitoring and recording of rainfall using cellular network infrastructure. He concluded that weather information such as rainfall is critical for successful agricultural activities. An Automated rainfall monitoring System is a more reliable and accurate way of monitoring the rainfall at any area compared to existing manual systems. This is particularly useful in remote areas that lack easy road access and manual measurement of rainfall is inconvenient. Development of remote automatic weather station with PC based data logger[3]is published by in the International journal of hybrid information technology vol.7, No.1 by Roneel V.Sharan. He concluded that the prototype AWS if evented into a finished product can be a great asset for weather data, monitoring especially for renewable energy project which require weather data measurement at remote location. Measurement of more weather data such as soil, temperature, solar radiation, wind direction, sunrise, sunset, atmospheric pressure, etc

Development of Pakistan's New Area Weighted Rainfall using Thiessen Polygon Method[4] in the Pakistan Journal of Meteorology Vol. 9, Issue 17: July 2012 by Faisal, N., A. Gaffar. He concluded that evaluated area rainfall quantity or area weighted rainfall (AWR), Thiessen Polygon is one of the widely used technique and important method. After the creation of new province, there was need for development of a spatially and temporally area weighted rainfall series for all the six sub regions (provinces), in addition to country as a whole. The new rainfall series constructed by this study is distributed uniformly all over the country and it represents all the existing provinces. In this study time series of area weighted rainfall have been developed using Theissen Polygen method, which is simple, fast and practical method. The newly time series represents an improvement over earlier, as it includes the rainfall data of hilly areas as well as plains and serves effectively for the requirement of existing need.

Development of Rainfall Intensity Duration Frequency Curves for Mumbai City, India [5]in the Journal of Water Resource and Protection,756-765 by P. E. Zope, Eldho T. I., V. Jothiprakash, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, India. He concluded that due to change in global mean temperature and hydrological changes, the higher frequency of rainfall may occur in the future as observed in the last few years in many parts of the world. Mumbai being the coastal city, surrounded by sea and creek, is vulnerable to flooding due to many reasons such as high intensity of rainfall, high tides, loss of drainage capacity due to design faults, development of reclaimed areas and improper knowledge and adoption of intensity of rainfall in designing the drainage system. As observed, the IDF curves derived by modifying the Kothyari and Garde's equation shows good results in the changing hydrologic conditions as reported on 26th July 2005 in Mumbai.

The climate of daily precipitation in the Alps: development and analysis of a high-resolution grid dataset from pan-Alpine rain-gauge data[6] in the international journal of climatology Int. J. Climatol. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/joc.3794 by Francesco A. Isotta,a* Christoph Frei,a Viktor Weilguni,b Melita Perˇcec Tadi´ c,c and they concluded that , the quality of the dataset was fundamentally reviewed by upgrading to the recent status of the national databases and by adopting a specifically designed quality control procedure that addresses common data coding errors and involved several semi-automatic checks. It is important that users of the Alpine precipitation grid dataset are aware of the limitations and uncertainties involved. Gridded datasets have become a popular and compact basis for describing the climate of a region. The present grid dataset offers a valuable resource of information on the precipitation climate of the Alpine region. Optimal design of rain gauge network in the middle Yarra rivar catchement Australia in the Hydrological processes[7] by Sajal Kumar Adhikary & Nitin Muttil. They concluded that this study has developed an optimal rainfall network for middle Yarra river catchment that consist of an optimal combination of rainguage station with the capability of providing more accurate area average as well as point rainfall estimates. The spatial structure & continuity of rainfall data where modelled by using three different variogram models (exponential, spherical & gaussian).

Automatic raingauge[8] published by Ibnu Sofwan Lukito, Sunarjo, Juana Rimba Meteorological, Climatological and Geophysical Agency (BMKG) Jakarta, Indonesia1,2,3 they discussed in the article that BMKG's technicians have successful developed an automatic rainfall observation system based microcontroller ATMega 128, GPRS and web server systems. This instrument is named ARG-BMKG (Automatic Rain Gauge-Meteorogical, Climatological and Geophysical Agency). This instrument has been tested through laboratory tests and field tests with the result was satisfactory. Hopefully, this engineering program can improve knowledge, skill and troubleshooting every BMKG's technician so they can support BMKG's weather instruments maintenance system in Indonesia.

An automatic weather station[9] published by Harry Diamond & Wilbur S. Hinman in the national bureau of standards vol, 25. They concluded that it is evident the system is quite simple. It allows the use of standard ratio transmitted & receiving equipment & standard weather instrument with but slight modification. The modulation & control equipment is special but it is more complicated in explanation than in actual design or operation. As described the system is readily adoptable to the addition of other measuring element such as electric hydrometer for improved measurement of relative humidity, photoelectric cells for measuring visibility & related factors etc. The signal may be interpreted without the need of special measuring & recording equipment.

The purpose of this paper is to describe the use of QGIS as tool for soil survey and mapping in Romanian methodological context and to analyse the efficiency of Open Source tools in this matter. Beginning with integrating data from various sources (GPS points, analogue and digital maps, analytical soil data, etc), continuing with editing and spatial analysis and finishing with map production, we have used QGIS and its add-ons in every stage of the soil survey and mapping process following, as much as possible, standard procedures specified by methodology. Also, we have searched for optimal solution in order to solve specific problems that may occur such as the type of topology for digitization (when the surveyor need to create data from scratch), how to integrate various databases, specific queries, etc. In conclusion QGIS, with his vast array of tools, can successfully be used in soil survey and for map production according to standards required by Romanian methodology. It can be implemented also very easily with minimum effort both technical and financial. After analysing all four stages of testing the application we can conclude that QGIS constitutes a viable and sustainable solution for creating and manage a Soil Information System. It contains all the tools needed for collecting and process the soil data, for creating complex spatial databases and for designing and publish professional looking maps. Being open source, it can be easily implemented, configured and extended to suit specific needs of soil surveying. Also, the costs are substantially reduced; the only expenses implied being for hardware, initial implementation and training. It has also some disadvantages derived also from being developed by an open community. It requires specialized expertise for integration with various external packages, especially when it is implemented on proprietary operating systems. Also, it needs numerous auxiliary applications to be installed process that can create confusion. Geological mapping is very important to display your field work in a map for geologist and others, many geologists face problems to make their field output in a geological map. I face that for long till I learn myself online through open QGIS source, and other software. QGIS is easy to understand and my goal here to provide an easy step to perform geological map with QGIS and some software, which you can use it for improve you map technically. I provide geological lithology symbols and some features you can use it side by side with QGIS, such as CLINO (MIDLAND VALLY) application which is found in Google play store for smart phones, also (TCX CONVERTER) as it will help you to pick many location points in one minute and projected in map which you are going to achieve if you miss it in field.

II. STUDY AREA

The study area SGI campus extends between 74^0 36’ E to 74^0 43’ E Longitude And 16^0 74’N to 16^0 80’N Latitude and it covers the 31.474sq.km area(Figure1). To prepare rainfall series, 10 rain-gauge stations have been selected for this study. The stations selected have the maximum available data for the period of ten years, covering time span from 2007 to 2017. Most of these selected stations have the data for the more than 90% of the years considered (2007-2017).
The Details of study area obtained by using GIS software is as mentioned below;

A. Study Area
SGI Atigre (Kolhapur district, Maharashtra)

B. Longitude
74^0 36’ E to 74^0 43’ E

C. Latitude
16^0 74’ N to 16^0 80’ N

D. Area
E. 325.1 km^2

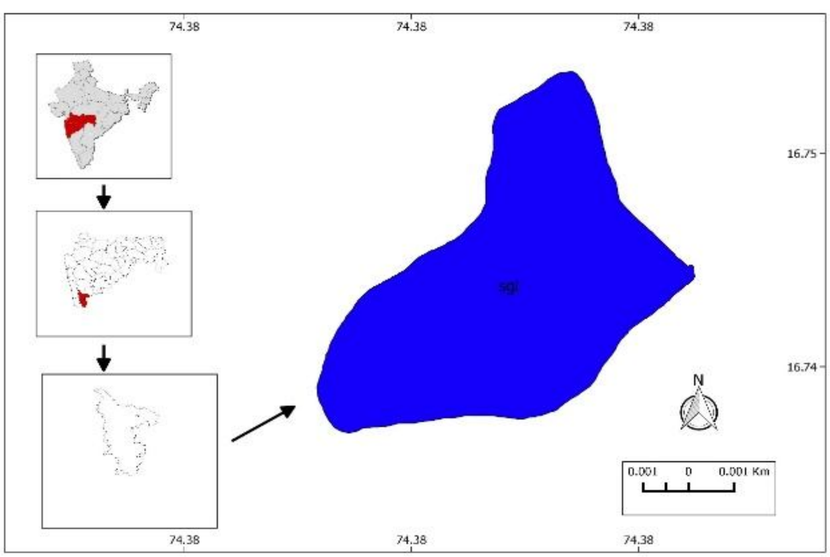

Fig.No.1 Map showing SGI campus.

III.PROBLEM POSED FOR STUDY

Sanjay Ghodawat Institute campus is located in the hilly area hence the rainfall intensity is more as well in the near by not a single raingauge station is available to measure precipitation. Also the main aim is to develop the water resources laboratory to enrich students about the concepts. The procedure followed to achieve the objective is mentioned below;

A. Collection of Toposheet of that area.
B. Develop location map with the help of GIS& Remote Sensing as well as manually.
C. Morphometric analysis with the help of Toposheet (manually) and QGIS2.6.1 (software).
D. Slope analysis of SGI campus with the help of QGIS2.6.1.
E. Select suitable site for installation of rain gauge station.

The measurement and mathematical analysis of the configuration of the earth's surface shape and dimensions of its land form provides the basis of the investigation of maps for a geomorphologic survey (Bates&Jackson,1980). This approach has recently been termed as morphometric. The area, altitude, volume; slope, profile and texture of land forms comprise principal parameters of investigation. Dury (1952), Christian, Jenning and Tuidale (1957) applied various methods for land form analysis, which could be classified in different ways and their results presented in the form of graphs, maps or statistical indices.
The morphometric analysis of the SGI campus was carried out on the Survey of India topographical maps No.47L/5 & 47L/6 on the scale1:50,000 and DEM with 30 x 30 m spatial resolution. The lengths of the streams, are as of the watershed were measured by using QGIS-2.6.1 - BRIGHTON software, and stream ordering has been generate by Strahler (1953) system, and Arc Hydro tool in QGIS-2.6.1 – BRIGHTON software. The linear aspects were studied using different methods. The average slope analysis of the watershed area was done using the Wentworth method. The Drainage density and frequency distribution analysis of the watershed area were done using the spatial analysis tool in QGIS-2.6.1 - BRIGHTON software. The drainage characteristics of Alate nala basin have been examined with reference to linear, aerial and relief aspects.

IV. SENSITIVITY ANALYSIS

To study the Sanjay Ghodawat campus we also require toposheet of Kolhapur district but during the time of study we know that only toposheet of Kolhapur district should not be sufficient also we require toposheet of Sangli district and these two toposheet we collected from survey of India. To calculate the rainfall data of SGI campus we require to know near by rain gauge station which are present in Sangli and Kolhapur district. We also collect the rainfall data of all of the near by rain gauge station to collect the data we visited hydrological department which are present in Kolhapur district. we got the data within one month and these data as below. All Rainfall data near to the SGI campus we are collected from hydrology project Nashik from 2005 to 2014.

B	Station name	Rainfall (mm)
1	Wadange	8634
2	Songe bange	9696
3	Sarud	9504
4	Sangli	1044
5	Mandukali	47080
6	Kagal	5697
7	Kadal	6058
8	Ajra	19766
9	Shigaon	17360

Table no 1-Rainfall data for existing rain gauge station

Contours are lines that connect points of equal value (such as elevation, temperature precipitation, pollution, or atmospheric pressure). The distribution of the lines shows how values change across a surface. Where there is little change in a value, the lines are spaced farther apart. Where the values rise or fall rapidly, the lines are closer together. By following the line of a particular contour, you can identify which locations have the same value. By looking at the spacing of adjacent contours, you can gain a general impression of the gradation of values. The example below shows an input elevation grid and the output contour map. The areas where the contours are closer together indicate the steeper locations. They correspond with the areas of higher eleva tion (in white on the input elevation grid).

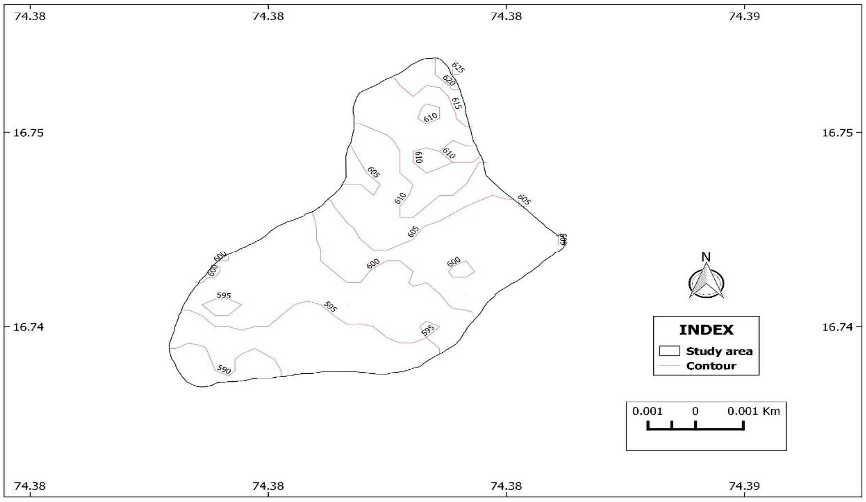

Fig.2 Contour map with Barrier of Study area

Slope identifies the steepest downhill slope for a location on a surface. Slope is calculated for each triangle in Tin's and for each cell in raster's. For a TIN, this is the maximum rate of change in elevation across each triangle. For raster's, it is the maximum rate of change in elevation over each cell and its eight neighbours. The Slope command takes an input surface raster and calculates an output raster containing the slope at each cell. Lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster can be calculated as percent slope or degree of slope

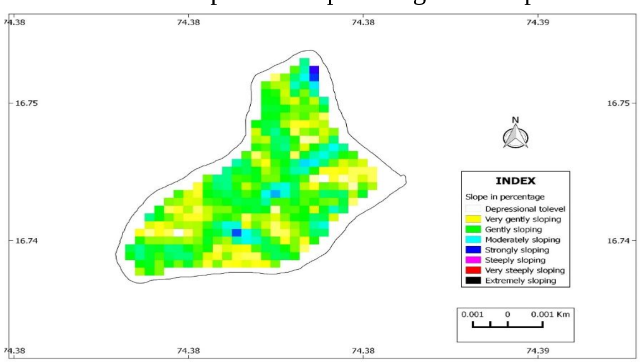

Fig.3 Slope Map of Study area

After the study of SGI campus formation of contour map and slope formation. And after studying the slope formation the point which have highest point of elevation these point we should select the best site for rain gauge station. The point will be located at the north-east side direction.

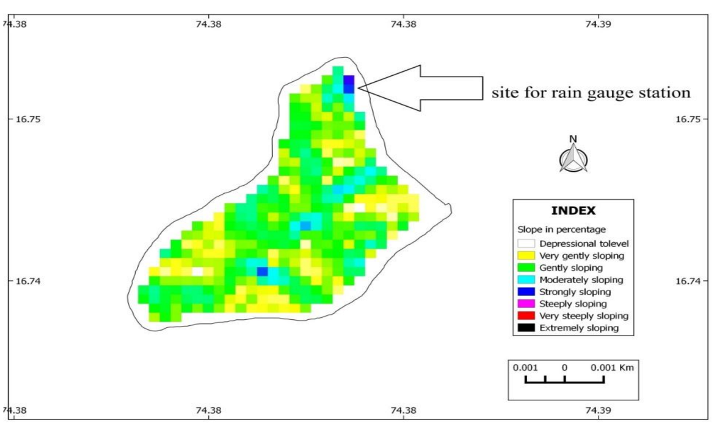

Fig 4 site selection for rain gauge station

To find the annual precipitation at SGI campus by using theissen polygon method. We want to locate the rain gauge station which are present to near to SGI campus and hence we are locate all of the rain gauge station point by using QGIS and google earth pro.

the catchment area for the study area is tried to plot by using QGIS software on that the existing rain gauge stations are contributing the catchment area is marked along with the proposed rain gauge . After marking the rain gauge station which are near to the SGI campus all of these points joined by straight line and formation of polygon image which should be located as below.

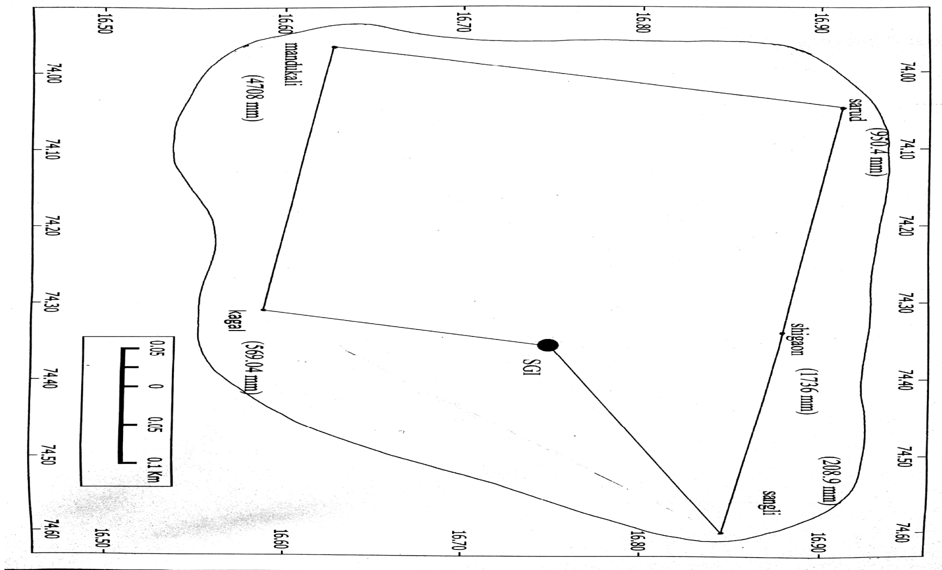

Fig No.5 Formation of catchment area and polygon image by connecting rain gauge station.

The Thiessen Polygon method is an interpolation method commonly used for precipitation but can be used on other point datasets. Thiessen Polygons are Voronoi Cells, a geometric means of dividing up an area given a set of known values at a relatively small number of points. This is a method which calculates station weights based on the areas of each station. The weights are then multiplied by the station precipitations to obtain the areal average precipitation.

The method of constructing the polygons implies the following steps:

Pm = avg. rainfall in the catchment

Pi = rainfall magnitude at the i^{th} station

Ai = area of influence for the i^{th} station

A = total area of the catchment

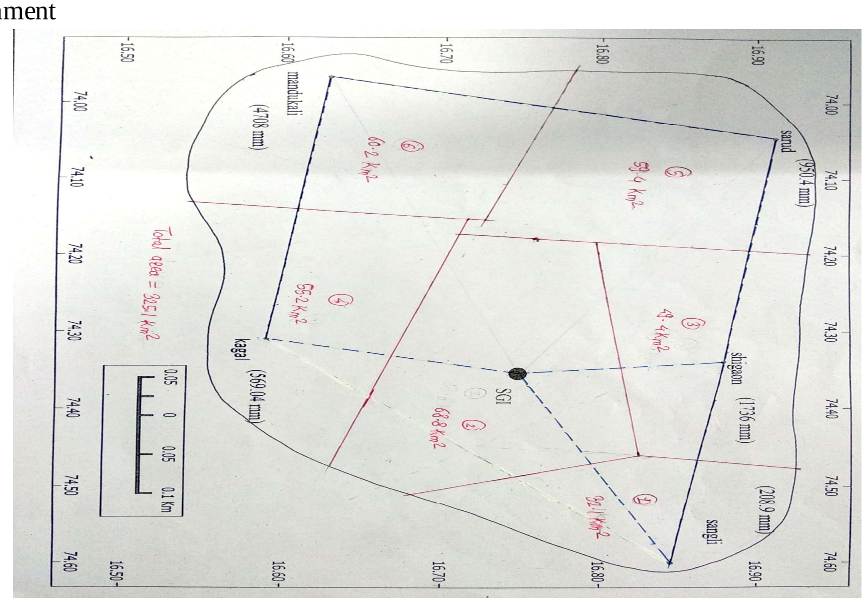

Fig No.15 Measurement of area by using digital plannimeter

The average rainfall in the catchment is 1634.47mm

$$Pm = \frac{P1A1+P2A2+P3A3+P4A4+P5A5+P6A6}{A}$$

$$Pm = \frac{(208.9\times32.1)+(P2\times30.3)+(1736\times87.9)+(569.04\times55.2)+(950.459.4)+(470860.2)}{325.1}$$

$$1634.47 = \frac{463750.46+68.8P2}{325.1}$$

$$P_2 = 982.79 \text{ mm}$$

By using Thiessen polygon method, we know the total annual precipitation in SGI campus is 982.79mm. This annual precipitation cross check the avg. annual precipitation of Hatkangale taluka and we form that the avg. annual precipitation of SGI campus should be nearly equal to the avg. annual precipitation of Hatkangale taluka.

After calculating the expected collection of average precipitation of raingauge station at SGI campus it is very important that to suggest proper type of raingauge station. From the survey of the campus availabity of parts and study of nearby raingauge stations it is advisable to go for tipping bucket type of rain gauge station. The detailed information is already mentioned in the earlier part of the report and the sketch is given below. This type is simple to establish and maintain after many years of establishment.

V. CONCLUSIONS

The main aim of the proposed study is to establish proper rain gauge station as there is no rain gauge station in the near by vicinity. As SGI campus is located in the hilly region it is appropriate sit for establishment of rain gauge. But to do this it is important to carry out survey of entire campus for proper location of gauge station this survey. This is carried out by using QGIS software, counters are plotted and fixed the location of the gauge station. The proper type is suggested as Tipping bucket. Then by available rainfall data by using Thiessen polygon method the attempt is made to calculate precipitation at proposed gauge possibly may get collect.

The total cost of the project is to estimated with construction and maintenance cost as 43,580/-

REFERENCES

[1] Aksara Putthividhya and Kenji Tanaka, (2012), “Optimal Rain Gauge Network Design and Spatial Precipitation Mapping Based on Geostatistical Analysis from Colocated Elevation and Humidity Data”. International Journal of Environmental Science and Development, Vol. 3, No. 2,

[2] Roneel V. Sharan, (2014), “Development of a remote automatic weather station with a PC based data logger”. International journal of hybrid information technology vol.7

[3] Ibnu Sofwan Lukito, Sunarjo, Juana Rimba: “Automatic Rain Gauge (ARG)” Metrological, Climatological and Geophysics Agency.

[4] S.P.K.A Gunawardena, B.M.D Rangana : “An Automated Rainfall Monitoring System” department of E&TC engineering, University of Moratuwa.

[5] N. Fasal. A. Gaffar, (2012),” Development of Pakistan’s New Area Weighted Rainfall Using Thiessen Polygon Method”, Pakistan Journal of Meteorology Vol. 9, Issue 17

[6] P. E. Zope, Eldho T. I.*, V. Jothiprakash,(2016), “Development of Rainfall Intensity Duration Frequency Curves for Mumbai City, India”. Journal of Water Resource and Protection, 8, 756-765.

[7] Francesco A. Isotta, (2013), “The climate of daily precipitation in the Alps: development and analysis of a high-resolution grid dataset from pan-Alpine rain-gauge data”. International Journal Of Climatology Int. J. Climatol..

[8] Sajal Kumar Adhikary , Nitin Muttil, (2015), “Optimal design of rainguage network in the middle Yarra river catchement of Australia.” Hydrological processes.29.

[9] Bogdan Rosca, Radu Pirnau, Iuliana Niculita, (2013),Soil survey and mapping by using QGIS software”.ResearchGate,

[10] Mohsen Alshaghdari, (2017),“Geological mapping using open source QGIS”. ResearchGate,.