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# Parametric Study on Watershed Development by using GIS and Remote Sensing for Water Budgeting

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**ABSTRACT:** Watershed management is the process of creating and implementing plans, programs, and projects to sustain and increase watershed functions that affect the plants, animal and human communities inside watershed boundary. The recent technologies like remote sensing and GIS support us to giving a quicker and cost effective analysis of various applications with accuracy for planning. It also gives a better perspective for understanding the problems and therefore helps planners evolve a better solution for sustainable development. From the final output of these themes generate, recharge wells, percolation tank and check dams are recommended for the study area, mainly to control sedimentation from the catchments. To increase the ground water recharge and vegetative cover to control soil erosion, various action plans like construction of recharge structures, afforestation etc. has been proposed. This project describes in brief the work carried out for the study area using remote sensing and GIS. Morph metric analysis is a quantitative description and analysis of landforms as practiced in geomorphology that applied to a particular kind of landform or to drainage basins. The present study proved the Remote sensing (RS), Geographical Information System (GIS) to be an efficient tool in delineation of drainage pattern and water resources management and its planning in Ahmednager District.

**Keywords:** Watershed management, the Remote sensing (RS), Geographical Information System (GIS)

## I. INTRODUCTION

Development of land and water resources is all essential elements for sustenance of humans. However, the haphazard and ad-hoc development, although apparently meets the immediate developmental needs but always tends to end in larger human misery in the long run. Hence, it is essential that the development plans besides sufficing the immediate necessities are also sustainable in the long-run. Water, with a wide spectrum of diversified applications, is the most essential element for sustenance of life forms. The quantitative estimation of water balance is essential in land and water resources development not only for economic appraisal of the project but also for assessing the reliability and sustained availability of water needs in the long run. The present study involves quantification of sub-components of water balance for pimpalgaon watershed of Ahmednager district, Maharashtra. The three major sub-components of water balance, namely SR, GWR, and ET were estimated at micro-watershed level. These components were estimated with appropriate combination of equations and field specific empirical relations as found in published literature. The present work aims at complementing previous efforts by taking a tour across this wide topic with the intention to serve as a met review, dedicated to both people interested in using remote sensing for agricultural applications and to the remote sensing community as a whole. We do not linger on specific comparisons between methods or results, nor do we recommend any single best way of using remote sensing for agriculture. Instead, the scope is to provide a thorough overview on what remote sensing has to offer for agricultural applications, while redirecting the readers to more specific reviews or study when necessary by citing the major references, and preferably the most recent ones. This study is divided in three main sections. The first one provides an outline of the current remote sensing techniques that are relevant for the agricultural context. It presents the agronomical variables and plant traits that can be estimated by remote sensing, and describes the empirical or

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deterministic approaches to retrieve them. The second part of this paper focuses on the way remote sensing contributes to answer to the specific requirements of different stakeholders for several key agricultural applications. Finally, we provide a synthesis of the emerging opportunities that should strengthen the role of remote sensing in providing operational, efficient and long-term services for agricultural applications.

Watershed management is the process of guiding and organizing land use and use of other resources in the watershed to provide desired goods and services without adversely affecting soil and water resources. Embedded in this concept is the recognition of the in this concept is the recognition of the inter-relationships among land use, soil and the linkages between uplands and downstream areas.

**Figure No.1: Watershed Management**

❖ **Watershed In India**

Approximately 170 million hectares in India are classified as degraded land, roughly half of which falls in undulating semi-arid areas where rain-ted farming is practiced. Long- term experiments by a number of research organizations in India in the 1970s and 1980s confirmed that the introduction of appropriate physical barriers to soil and water flows, together with re vegetation, could generate considerable increases in the resource productivity. These, in turn, stimulated the formulation of a number of government projects, schemes and programme5 in support of microwatershed development

In India, micro-watersheds arc generally defined a tailing in the range 500- 1000 ha. A macro-watershed is equivalent to a river basin and may encompass many thousands of hectares. The micro-watershed concept aims to 'establish an enabling environment for the integrated use, regulation and treatment of water and land resources of a watershed-based ecosystem to accomplish resource conservation and biomass production objectives. Although a macro-watershed may be a sensible unit from biophysical perspective, many would argue against the appropriateness of such a unit for rural development. Social institutions to promote cooperation-needed to protect and rehabilitate private and common-pool resources are usually village based. Often, however, biophysical and socio-political boundaries do not coincide. The majority of project docs not, therefore, strictly entail the development of 'a watershed'; rather they adopt an approach to rural development incorporating principles from the watershed approach

❖ **Problem Statement**

India is affected with unevenness of weathering conditions. Every state and regions of nation has different topographical conditions, due to this the rate of rainfall and its intensities are different within every region. In past few years in Maharashtra most of the region are facing drought due to uncertainty of rainfall. To overcome from this issue there is need to implement the effective method to increase the ground water table and natural resources of water.

## II. LITERATURE REVIEW

✔ **Estimation of Water Balance Components of Watersheds in the Manjira River Basin using SWAT Model and GIS (2020)**

This study mainly focus on hydrological behavior of watersheds in The Manjira River basin using soil and water assessment tool (SWAT) and Geographical information system (GIS). The water balance components for watersheds in the Manjira River were determined by using SWAT model and GIS. Determination of these water balance components helps to study direct and indirect factors affecting characteristics of selected watersheds. Manjira River contains total 28 watersheds among them 2 were selected having watershed code as MNJR008 and MNJR011 specified by the Central Ground Water Board. The SWAT input data such as Digital elevation model (DEM), land use and land cover (LU/LC), Soil classification, slope and weather data was collected. Using these inputs in SWAT the different water balancing components such as rainfall, baseflow, surface runoff, evapotranspiration (ET), potential evapotranspiration (PET) and water yield for each watershed were determined. The evaluated data is then validated by Regression analysis, in which two datasets were compared. Simulated rain data from SWAT simulation and observed rain data from Global Weather Data for SWAT was selected for comparison for each watershed.

✔ **MODFLOW Based Groundwater Budgeting Using GIS: A Case Study from Tirunelveli Taluk, Tirunelveli District, Tamil Nadu, India, (2018)**

Extensive use of freshwater resources for day-to-day human consumption will cause alarming situations in environmental water balancing. Groundwater is considered as the primary source for living organism due to limited availability of surface water systems in arid and semi arid regions. An attempt is made in this study, to develop numerical simulation of groundwater flow and quantification of groundwater availability in Tirunelveli taluk using Remote Sensing and GIS techniques. The study area lies between eastern longitudes of 77-320 1600 and 77-480 800 and northern latitudes of 8-400 1200 and 8-560 3400 with a spatial extent of 558.4 sqkm. The initial input parameters of MODFLOW such as boundary conditions and layer properties are prepared from data issued by Public Works Department. The data consists of groundwater level, aquifer property and lithology. Topographic map was received from Survey of India. SRTM DEM was downloaded from USGS web archives and resembled the above data using Arc GIS environment. Model Muse package of USGS was used to develop the quantitative three dimensional steady and transient state flow model of groundwater system, based on the available hydrological field data. The calibration process of Model Muse simulated groundwater flow result was carried out using, field based well water level data collected for the study period using Model Mate package. The simulated results have shown the over extraction activity of groundwater resource (103.696 m3) is performed in the study area. This study also demonstrates that integration of Remote Sensing, GIS, traditional fieldwork and mathematical models is a powerful tool in understanding the demand and supply of groundwater.

✔ **Information System for Integrated Watershed Management Using Remote Sensing and GIS (2014)**

Watershed management is an endowed approach to mitigate the gap between demand and supply of water and other natural resources, particularly in the fragile arid and semi-arid tropics (SAT). As this is a complex phenomenon, there is need for a reliable Information System/Decision Support System (DSS). Watershed Management Information System (WATMIS) is a viable and generic toolkit for integrated watershed planning and management of its natural resources using multiple technologies like Geographical Information System (GIS), Remote Sensing (RS), Global Positioning System (GPS), hydrological modelling and soft computing tools. In this system, an attempt has been made to integrate dimensions in Agriculture–Water–Soil–Climate continuum for sustainable management of land and water resources judiciously. The application of WATMIS will be useful to various stakeholders such as agriculturists, rural extension community and water resources managers for better decision making.

## III. THEORETICAL STUDY OF REMOTE SENSING AND GIS

### 1 Why is watershed Important?

Watershed is an area, which catches the water from precipitation and then is drained by a river and its tributaries. It is a “resource region” where the ecosystem is closely interconnected around a basic resource - water. The watershed or river basin is therefore an ideal management unit. The watershed provides a powerful study and management unit, which integrates ecological, geographical, geological, and cultural aspects of the land. The watershed is also a useful concept for integrating science with historical, enriching, economic, and political issues. Water (movement, cycling, use, quality, etc.) provides a focus for integrating various aspects of watershed use and for making regional and global connections Using the watershed concept, one can start with study of any number of small sub systems (e.g., a particular marsh or sub-watershed; or a particular pollutant, such as salt), and continually relate these small-scale issues to questions of larger-scale watershed system health. We all live in a watershed. Watersheds are the places we call home, where we work and where we play. Everyone relies on water and other natural resources to exist. What you and others do on the land impacts the quality and quantity of water and our other natural resources. Healthy watersheds are vital for a healthy environment and economy.

Our watersheds provide water for drinking, irrigation and industry. Many people also enjoy lakes and streams for their beauty and for boating, fishing and swimming. Wildlife also needs healthy watersheds for food and shelter Effective and efficient way to sustain the local economy and environmental health. Scientists and leaders now recognize the best way to protect the vital natural resources is to understand and manage them on a watershed basis. Everything that is done in a watershed affects the watershed's system.

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## 2 What is GIS

GIS stands for geographic information system. An information system is a computer program that manages data. A GIS, then, is a type of information system that deals specifically with geographic, or spatial, information. Like other information systems, a GIS requires lots of data that it can access, manipulate, and use to produce a product. Geographic information describes the spatial (location) factors of an object or area. This can be simply latitude and longitude coordinates, but in most cases more complex factors are included. As for a formal definition of GIS, defines GIS as follows: A get geogeographic information system (GIS) is a computer-based information system that enables capture, modeling, manipulation, retrieval, anal- ysis and presentation of geographically referenced data. The definition provided by The Oak Ridge National Laboratory: GIS is "a digital representation of the landscape of a place (site, region, planet), tructured to support analysis." Under this broad definition, GIS conceivably may include process models and transport models as well as mapping and other spatial functions. The ability to integrate and analyze spatial data is what sets GIS apart from the multitude of graphics, computer-aided design and drafting, and mapping software systems.

## 3 Role Of Geographic Information System In Watershed Applications

Geographic information System is a system for capturing, storing, checking, manipulating, analyzing and displaying data, which are spatially referenced to tlic earth. GIS is any manual or computer based set of procedures used to store and manipulate geographically referenced d.lta.

GIs can play an important role in inventory and data handling activities of land use and land cover. A CIS accepts, organize, analyze statistically and display various types of spatial information. These variables are achieved in a computer compatible digital formula as a reference or database. Database represents various kinds of aerial information e.g.; terrain description, soil and lithology types, land cover and land use, population density and climate etc.

Elements: There are five basic technical elements in a CIS, viz encoding, data input, data management, manipulative operations and output products.

GIS are capable of performing the surface analysis and overlay analysis. Surface analysis for instance, comprises of the inclusion of soil categories, their analysis and labeling according to agricultural value. In the automated overlay analysis, the GIs overlay two or more data plains and explicit their relationships. Finally the GIs can retrieve and display data in tabular or graphic form or both. The system can produce hard copies, charts, scatter diagram, tables and maps.

## 4 Role of Remote Sensing (RS) in Watershed Management

Remote sensing is the non-contact recording of information from various electro-magnetic spectrum regions by means of instruments such as cameras, scanners, lasers, linear arrays and/or area arrays located on the ground or Arial platforms and the analysis of the acquired information by means of visual and digital image processing. Remote sensing, with or without GIS technology, has emerged as an indispensable scientific tool for mapping and planning of natural resources. It plays a hastily escalating role in the field of hydrology and sustainable water resources development and management. These techniques have been extensively applicable in nearly all fields of watershed aspects, like, estimation of evapotranspiration, soil erosion, rainfall runoff modeling flood management and irrigation water management.

## 5 Water Budgeting

Water budgeting is a water management tool used to estimate the amount of water a landscape will require. It can be calculated for a single irrigation event, on a weekly or monthly basis, or even annually.

It is considered that the main recharge to the ground water is mainly through the infiltration of precipitation, as it occur and percolates from surface storage to the ground. Water budgeting equation as follow:

Water Budgeting equation as follow:

Total precipitation = (Runoff = Evaporation + Stored water on groung

A water budget is a basic tool which can be used to evaluate the occurrence and movement of water through the natural environment. The quantification of water budgets and the underlying hydrological processes provide an interdependent foundation for the other ecological, social and economic components within the natural and anthropogenic environments. Some additional necessary tools for the management of watershed processes include those to assess ecological water needs, sediment transport processes, transport of dissolved parameters (nutrient, contaminant, microbiological etc.), surface water hydraulic analysis and groundwater flow. All of these tools and subsequent assessments are interdependent and can feed into each other. This water budget tool can

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be very simple or very complex depending on the environment.

**Figure No.2: Water Budget**

## IV. STUDY AREA

### 1. Study Area Pimpalgaon Ujjaini in Ahmednagar District of Maharashtra

The watershed located at Pimpalgaon Ujjaini in Ahmednagar District of Maharashtra state, India as shown in figure Maharashtra, has only 13 % of the cropped area under irrigated water, and the remaining area is dependent on rainfall only. In this state larger flow irrigation projects are working but it cannot satisfy irrigation water need for all, particularly at rural community level. Therefore, planning these units; using recent tools and techniques, and in situ methods of soil and water conservation at micro watershed and/village level is necessary. The watershed is located between to $74^0 45' 00''$E to $74^0 51' 00''$ longitude and $19^0 08' 43''$N to $19^0 11''$ N latitude.

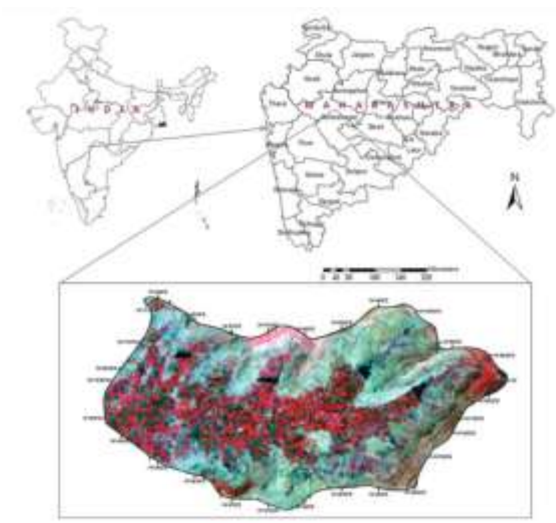

**Figure No.3: Ahmadnagar Is Nearest Town To Pimpalgaon Ujjaini For All Major Economic Activities, Which Is Approximately 16km Away.**
**Figure No.4:**

### 2. Water Balance Equation

The Water Budgeting is broadly done using basic water balance equation given below

$W_{nt} = R - GWR - ET_a - S_w$……………………….
….(1)

Where,
Wn t is net change in water resources of watershed at time t,
R is input from Rainfall,
Sw is surface runoff calculated with SCS curve number method,
GWR is recharge to the ground water, which is estimated based on procedure given in Ground Water Potential Evapotranspiration (ETo) is calculated from Hargreaves-Samani method. ET o is further related to vegetation coefficient to account for actual land use/land cover, and from this actual Evapotranspiration (ETa) is calculated. Based on this, available net water balance is calculated on monthly and annual basis. The above calculations are repeated for predevelopment and projected post-development scenarios.

### 3. Surface Runoff Computation

Runoff is defined as the net liquid water supplied to channels at time-scales comparable with the duration of the storm after evapotranspiration, interception, surface retention, infiltration and percolation to underlying aquifers. Infiltration being the main factor affecting the amount of water available for runoff, the Curve Number (CN) model developed by the Soil Conservation Service (SCS) of USDA 0968) was used for estimating runoff in a watershed. SCS curve number method has been used to quantify the hydrologic response of watershed to land use change Most of the parameters that affect runoff are incorporated in this model. Some of the parameters of this model are amenable to remote sensing. Hence this model was chosen for this study. The SCS CN model is as follows:

$Q = \frac{(P - I_a)^2}{(P - I_a + S)}$……………………………………..(
2)

Where,
Q = runoffvalue in mm;
P = Precipitation in mm;
Ia = Initial abstraction in mm;
S = potential maximum retention and is given as

$S = \frac{254000 - 254}{CN}$…………………….(3)

and I a = 0.3XS forAMC- I
la = 0.1X S forAMC-I I and AMC-IIl

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The Runoff curve number CN is a function of land use, treatment and condition; infiltration characteristics of the soils; and antecedent moisture condition (AMC). Curve number for AMC condition III and I were calculated from the following formulae:

$$CNI = \frac{4.2XCNII}{(10 - 0.058XCNII)}$$

CNIII = …………………………(4)

## 4. Ground Water Recharge Estimation

Surface Runoff Computation Runoff is defined as the net liquid water supplied to channels at time-scales comparable with the duration of the storm after evapotranspiration, interception, surface retention, infiltration and percolation to underlying aquifers. Infiltration being the main factor affecting the amount of water available for runoff, the Curve Number (CN) model developed by the Soil Conservation Service (SCS) of USDA 0968) was used for estimating runoff in a watershed. SCS curve number method has been used to quantify the hydrologic response of watershed to land use change. Most of the parameters that affect runoff are The ground water recharge or infiltration and percolation of water into aquifer were estimated from the guidelines given in the GWREC repor. The ground water recharge component consists of recharge due to rainfall, water bodies, and water harvesting structures were taken into consideration. The static ground water was not estimated as it is part of deep aquifer system, and as such does not influence the dynamic water balance of watershed.

### 1. Recharge from Rainfall

The value of rainfall recharge rates were used as per guidelines given in the GWREC Report (1997). Geomorphology and lithology data was used to decide different rainfall recharge rates as per given norms.

### 2. Recharge from Water Harvesting Structures

The main proposed water harvesting structures for the check dam recharge, check dam storage, percolation tanks. As per guidelines from the GWREC, the value of recharge from these structures is taken for this study. Recharge rate From Various Water Harvesting Structures Is Given In Table 3.1

**Table No 1: Recharge For The Water Harvesting Structures.**

| Existing water structure | No |
|---|---|
| Percolation tank | 94.00 |
| Check dam recharge | 263.00 |
| Check dam storage | 263.00 |

### 5. Evapotranspiration Estimation

Evapotranspiration is calculated in two parts, first potential or reference ET is calculated and then actual ET is calculated using different crop coefficients for different land use/land cover classes.

$ET_a = ET_p x K_c$

………………………………….(5)

Where,

ETp, reference potential evapotranspiration, which is calculated using Hargreaves-Samani equation and Kc is the coefficient related to actual land use/land cover.

Hargreaves-Samani Method

$ET_p = 0.00135x(T_{mean} + 17.8) \cdot R_s$…………………

…………………(6)

$R_s = k_{RS} X[\sqrt{(T_{max} - T_{Min})}]xR_a$ …………(7)

Where,

ETp is reference evapotranspiration in mm/ day,

Tmean is the mean temperature,

Tmax is the maximum temperature,

Tmm is the minimum temperature,

kRs is a adjustment coefficient, $k = 0.17(^0C^{-0.5})$

Ra is extraterrestrial solar radiation in MJ m2day

The daily extraterrestrial solar radiation is calculated for our study area (latitude of 240 N) using physical relations as per Burman and Pochop (1994). Crop coefficient K~ for both pre-development and post-development land use land cover classes

## V. RESULT AND DISCUSSION

Ahmednagar district, which is known as "Rural Development in Co-operation" and "Land of Saints", is situated in middle of western Maharashtra adjoining Nashik in the northern part, Beed and Osmanabad in the east, Aurangabad in the north east, Pune in the west and Solapur in the southern part. The district being first in terms of geographical area. The district lies between north latitudes 18°12' and 19°54' and east longitudes 73°54' and 75°30'. The total area of the district is 17196 sq km and falls in parts of Survey of India degree sheets 47 I, 47 M, 47 J, 47 N and 47 E.

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**Figure No.5: Ahmednagar District**

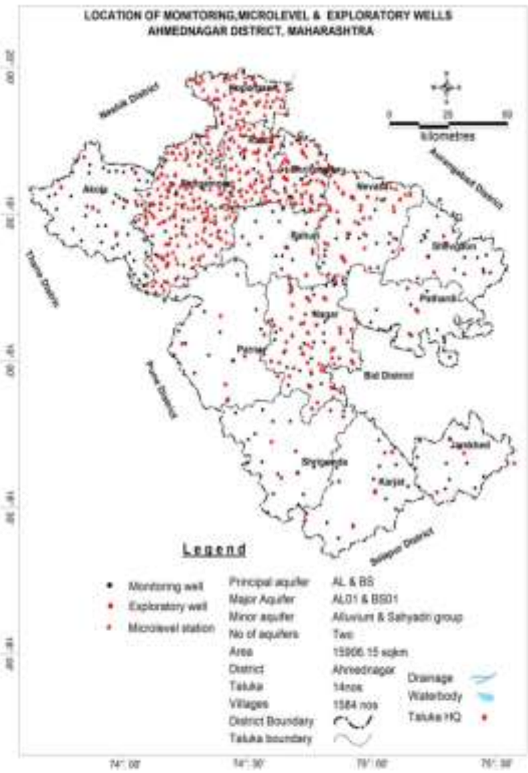


**Figure No.6: Location Of Existing Well And Ground Water Monitor Well**

**1 Geomorphology, Drainage and Soil Types**

The district lies partly in Godavari basin and partly in Bhima basin. The northern part of the district is drained by Godavari River and its tributaries viz., Pravara, Mula, Adula and Mahalungi whereas the southern part is drained by Bhima River and its tributaries viz., Ghod and Sina.

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All the rivers have sub-parallel to semi-dendritic drainage pattern and the drainage density is quite high. Based on geomorphologic setting and drainage pattern, the district is divided into 80 watersheds. The soils in the district are derived from the Deccan basalt formation. Clayey very deep soil covers major part of the district covering Kopargaon, Rahata, Srirampur, Rahuri, Newasa and parts of Nagar, Srigonda, Shevgaon, Pathardi and Jamkhed. Gravelly sandy clay loam shallow to very deep and gravelly loam moderately deep covers rest of the area covering Akole, Sangamner, parts of Rahata, Shevgaon, Parner, Nagar, Pathardi and Karjat.

## 2 Climate and Rainfall

**Table No 2: Rainfall Data**

| Year | Sw Monsoon Rainfall (mm) | | Annual Rainfall (mm) | |
|---|---|---|---|---|
| | Rainfall | % Departure | Rainfall | % Departure |
| 2000 | 798.1 | -10% | 1035.4 | -13% |
| 2001 | 818.8 | -8% | 1100.7 | -7% |
| 2002 | 700.5 | -21% | 935.9 | -21% |
| 2003 | 902.9 | 2% | 1187.3 | 0% |
| 2004 | 807.1 | -9% | 1106.5 | -7% |
| 2005 | 874.3 | -1% | 1208.3 | 2% |
| 2006 | 889.3 | 0% | 1161.6 | -2% |
| 2007 | 943 | 6% | 1179.3 | -1% |
| 2008 | 877.8 | -1% | 1118 | -6% |
| 2009 | 698.3 | -21% | 95.7 | -20% |
| 2010 | 911.1 | 3% | 1215.5 | 2% |
| 2011 | 901.3 | 2% | 1116.3 | -6% |
| 2012 | 823.9 | -7% | 1054.7 | -11% |
| 2013 | 937.4 | 6% | 1242.6 | 5% |
| 2014 | 781.7 | -12% | 1044.7 | -12% |
| 2015 | 765.8 | -14% | 1085 | -9% |
| 2016 | 864.4 | -3% | 1083.2 | -9% |
| 2017 | 845.6 | -5% | 1127.1 | -5% |
| 2018 | 804.1 | -9% | 1020.8 | -14% |
| 2019 | 971 | 10% | 1288.8 | 10% |
| 2020 | 961.4 | 9% | 1289.6 | 10% |

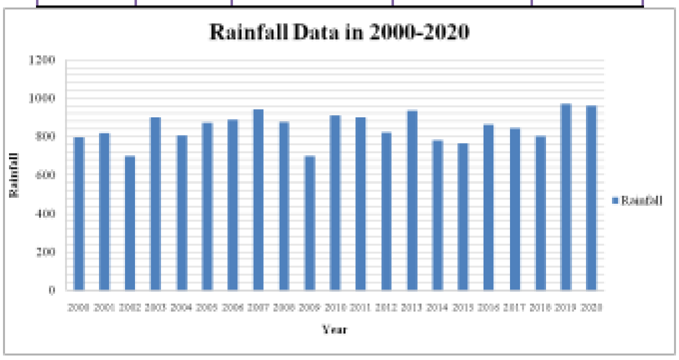


**Figure No.7: Rainfall Analysis in Ahmednager District**

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## 3 Water Balance Components

**Table No 3: Data to be Considered**

| Sr. No | Nager Taluka | | Year 2019 | 2020 |
|---|---|---|---|---|
| 1 | Geographical Area | | 1605.74 | 1605.74 |
| 2 | Forest Area | | 131.65 | 131.65 |
| 3 | Climate | | Sub Tropical | |
| 4 | Rainfall | | 971 mm | 961.4 mm |
| 5 | Cultivable Area | | 1319 | 1325 |
| 6 | Area Under Irrigation | Surface Water | 0 | 0 |
| | | Ground Water | 175.98 | 180.2 |
| 7 | Temperature | Max | 33.4 ℃ | 38.6 ℃ |
| | | Min | 26.6 ℃ | 30.4 ℃ |

**Table No 4: Water Balance Component for Rainfall**

| Year | Crop Type | Pre Development | Post Development |
|---|---|---|---|
| **2019** | Kharif - Cotton, Bajra, oilseeds, soyabean | 438.719 | 434.088 |
| | Rbbi - wheat, pulses, oats | 438.174 | 438.719 |
| | Cash crop - Sudercane | 434.088 | 438.719 |
| **2020** | Kharif - Cotton, Bajra, oilseeds, soyabean | 351.927 | 346.841 |
| | Rbbi - wheat, pulses, oats | 351.329 | 351.927 |
| | Cash crop - Sudercane | 346.841 | 351.329 |

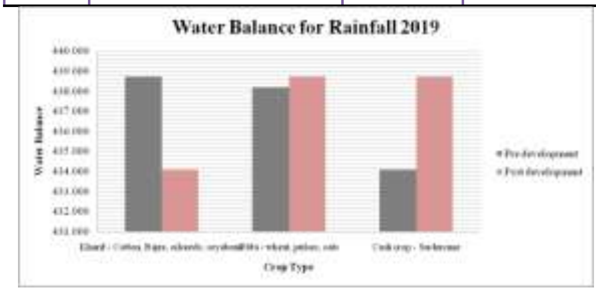


**Figure No.8: Water Balance in Pre-development for Year Rainfall 2019**

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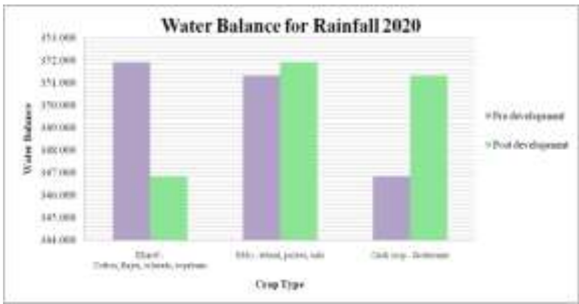


**Figure No.9: Water Balance in Post-development for Year Rainfall 2020**

**Table No 5: Water Balance Component For Water Harvesting Structure**

| **Year** | **Existing Water Structure** | **Pre Development** | **Post Development** |
|---|---|---|---|
| **2019** | Percolation tank | 787.16 | 782.53 |
| | Check dam recharge | 868.44 | 868.98 |
| | Check dam storage | 538.50 | 543.13 |
| **2020** | Percolation tank | 767.27 | 762.18 |
| | Check dam recharge | 848.49 | 849.09 |
| | Check dam storage | 518.15 | 522.63 |

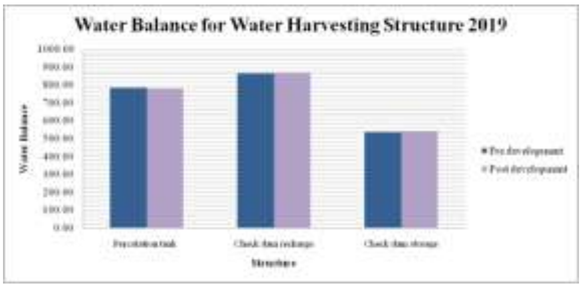


**Figure No.10: Water Balance for Water Harvesting Structure in 2019**

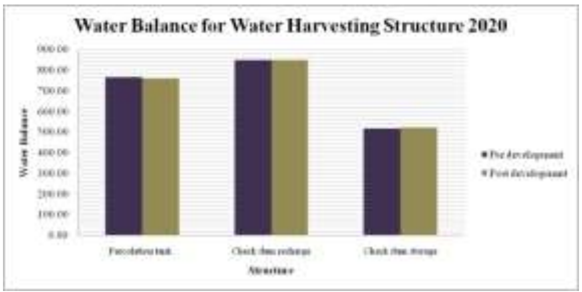


**Figure No.11: Water Balance for Water Harvesting Structure in 2020**

## 4 Surface Runoff

**Table No 6: Calculation Of Surface Runoff**

| **Year** | **Monthly Precipitation** | **Potential Maximum Retention** | **Initial Abstraction** | **Surface Runo** |
|---|---|---|---|---|

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| | | | | | ff |
|---|---|---|---|---|---|
| | p (mm) | CN | S (mm) | Ia | Q(mm) |
| **2019** | 244.6 | 68 | 369.7941 | 110.9382 | 35.48567 |
| **2020** | 264.5 | 68 | 369.7941 | 110.9382 | 45.05771 |

## 5 Ground Water Recharge Estimation

**Table No 7: Estimation of GWR for Rainfall**

| Year | Annual Rainfall | Infiltration Rate | Recharge To Commanded Area | GWR |
|---|---|---|---|---|
| | (mm) | F | F (1319e+15)) | |
| **2019** | 971 | 14% | 3600.413 | 489.44 |
| **2020** | 961.4 | 16% | 3616.72 | 556.34 |

**Table No 8: Estimation of GWR for Water Harvesting Structure**

| Year | Existing Water Structure | No of Structure | Efficiency Of Recharged 0.75 % | Capacity | Induced Recharge |
|---|---|---|---|---|---|
| | | | | TCM | MCM /Year |
| **2019** | Percolation Tank | 94.00 | 0.75 | 200.00 | 141.00 |
| | Check Dam Recharge | 263.00 | 0.75 | 30.00 | 59.18 |
| | Check Dam Storage | 263.00 | 0.40 | 30.00 | 385.03 |
| **2020** | Percolation Tank | 94.00 | 0.75 | 200.00 | 141.00 |
| | Check Dam Recharge | 263.00 | 0.75 | 30.00 | 59.18 |
| | Check Dam Storage | 263.00 | 0.40 | 30.00 | 385.03 |

## 6 Evapotranspiration Estimation

**Table No 9: Estimation of Evapotranspiratuon**

| Year | Crop Type | Kc Coefficient Land use And Land Cover | | Eta (pre) | Eta (post) |
|---|---|---|---|---|---|
| | | Pre - Development | Post Development | | |
| **201** | Kharif - | 0.27 | 0.44 | 7.355 | 11.98 |

| | | | | | |
|---|---|---|---|---|---|
| **9** | Cotton, Bajra, oilseeds, soyabean | | | | 7 |
| | Rbbi - wheat, pulses, oats | 0.29 | 0.27 | 7.900 | 7.355 |
| | Cash crop - Sudercane | 0.44 | 0.27 | 11.987 | 7.355 |
| **2020** | Kharif - Cotton, Bajra, oilseeds, soyabean | 0.27 | 0.44 | 8.077 | 13.163 |
| | Rbbi - wheat, pulses, oats | 0.29 | 0.27 | 8.675 | 8.077 |
| | Cash crop - Sudercane | 0.44 | 0.29 | 13.163 | 8.675 |

**7 Hargreaves-Samani Method**

**Table No 10: Calculation of Hargreaves-Samani Mathod**

| Year | Adjustment Coefficient Krs | Maximum Temperature (Tmax) | Minimum Temperature Tmin | Extraterrestrial Solar Radiation In MJ M2day -1 Ra | Solar Radiation (MJ M2day -1) Rs | Etp (Mm/Day) |
|---|---|---|---|---|---|---|
| 2019 | 4.32 | 33.4 | 26.6 | 37.49 | 422.2 | 27.24 |
| 2020 | 4.32 | 38.6 | 30.4 | 37.49 | 463.6 | 29.92 |

## VI. CONCLUSION

Following conclusion can be listed below:
This can help giving greater responsibility to the different stakeholders while keeping their autonomy. The following concluded is listed

- In view of the global village concept the responsibilities of the governance and the civic of the developing countries have increased to ensure the proper. scientific use of the limited financial resources to maintain and monitor the natural resources in general and the water resources in particular to emulate the living standards of its countrymen.
- Governments have been spending crores of rupees to conserve and augment the water resources. There is every need to have a rational and scientific approach to measure the impact of the steps taken
- Since the better advantages in terms of spatial and temporal aspects of Remote Sensing Technology aided with GIS tool can be preferred as a substitute for the time taking, harduous, high cost, traditional conservative approaches.
- In the development of performance indicators to assess the impact the approach adopted in this study is by considering the vegetative change through the measurement of lndia Red and Red band signals (NDVI) besides the Socio-economic components may be considered as a scientific and rational approach towards the impact assessment of integrated watershed management.

- The model developed in this study may be applied elsewhere under similar environments for impact assessment of watersheds.
- Based in Calculation the following results are listed:

✔ **Surface Runoff**

As monthly rainfall data for Ahmednagar District was available for 20 years (2020 to 20020), the surface runoff component was calculated on Monthly basis for all 20 years, and it was then calculated for all the microwatersheds. It was found that surface runoff has reduced for most of the micro-watersheds. The average annual value of 35.48 mm and 45.057 mm is found for pre and post-development plans.

✔ **Ground Water Recharge**

The recharge from rainfall was calculated on the basis of geomorphologic and lithological considerations; the recharge increases substantially for most of the micro-watersheds after the implementation of the water resources action plan, which recommends construction of various recharge structures such as check dams, percolations tanks, etc. The total ground water recharge was found to be 141.0 mm for pre-development and post-development scenarios and check dam storage for 385.03 mm

✔ **Evapotranspiration**

The computation of ETa showed that there is net increase in the ETa needs of the watershed after the post-development scenario. It was found that actual evapotranspiration is the deciding factor in the total water balance of study area. The pre-development Eta found in kharif crop to be 7.355 mm in 2019 and 2020 year Eta found in kharif crop is 8.077mm. The post -development Eta found in kharif crop to be 11.987 mm in 2019 and 2020 year Eta found in kharif crop is 13.163mm.

## VII. FUTURE SCOPE

By developing watershed in proposed selected region, it will improve Socio-Economical condition of local farmers. Also at the appropriate location water and soil conservation structure suggested, which gives benefit to local farmer. Ground water level in various micro-watersheds can increase through proper management & by constructing various water and soil conservation structures. To understand the differential recharge condition in watershed, use of GIS and remote sensing gives higher accuracy in proposed region.

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