MANTECH Publications

Journal of Water Resource Engineering & Pollution Studies

Volume 7, Issue 1, January- April, 2022

Evaluation of Impact on Watershed by Using Various Indices- An Overview

Akshay S. Kalmegh [1]***, Dr. Nitin W. Ingole***[2]

P.G. Student[1]*, Professor & Dean (R&D)*[2]

Dept. of Civil Engineering

Prof. Ram Meghe Institute of Technology and Research, Badnera, Amravati (MS)

Corresponding Author's Email: - *kalmeghask@gmail.com*[1]

Abstract

This paper provides an overview of the implementation and obstacles of watershed management, and the alternative solutions based on a synoptic review of related studies and experiences in watershed area. Evaluation of impact on watershed by using different indices was carried out to evaluate the watershed performance of Indla-Ghatkhed watersheds. These watersheds are in satpuda region, Amravati district, Maharashtra, India. Watershed is not simply the hydrological unit but also socio-political ecological security and provides life support services to rural people. The criteria for selecting watershed site also depend on the objectives of development and terrain slope. Watershed project plays important role in managing soil and water resources through the world. During the study of papers additional treatments suggested for the watershed area are graded bund, loose boulder structure, gabian structure, cement plug, Field trench, Dry land horticulture, Far Pond and plantation along with new treatments like WANT and gully plug have been recommended for better results. It was observed that the farmers in Indla-Ghatkhed watershed have participated moderately in the watershed development programme planning and implementation stages, whereas, high level of participation was exhibited by farmers in maintenance stage of watershed development programme.

Keywords*: Watershed development, Management Indicator, Socio-economic indicator, Water conservation, Sustainability Indicator.*

INTRODUCTION

Water is important for all living being on the earth. Water is used in domestic, agricultural, industry, irrigation and other purpose too. As population is rapidly growing, the demand for the water is also increasing day by day for different purposes. Thus, conserving water is not only our duty but also necessity for the survival for the present and future generation.

(Manchand Singh, 2017). One of the definitions of watershed management is "the process of creating and implementing plans, programs and projects to sustain and enhance watershed functions that affect the plant, animal and human communities within a watershed boundary". In spite of sufficient rainfall, people have to face water scarcity for their use especially supply in summers in most of the area. This is mainly due to large run off which is responsible for water loss as well as the soil in land. Watershed management involves the judicious, organization, peoples in harmony with the ecosystem. (pradeep M Ronghe, 2017) For development of agriculture and drinking water resources, but about managing human activity as it affects these resources the basic element required are land and water. Watershed management is not so much about managing natural resources, but about managing human activity as it affects these resources. It enhances the ground water table and soil moisture is retained for longer area under rainfed cultivation which requires arrestation of erosion and increase soil moisture retention period which can be achieved by covering rainfed area under watershed development programme. The aim of this study was sustainable development in the Indla-Ghatkhed watershed area through soil and water conservation activities. (Vinchurkar S.S. 2012). here is a need to monitor and evaluate the impact of soil conservation and watershed development projects that are multi- sectoral in essence from various points of view to achieve the objective of sustainable development. Interventions to conserve soil and develop watersheds are being undertaken globally by a wide variety of agencies, but we need to have instruments to assess the impact of these interventions. This means identifying the variables that the interventions are aiming to affect, indicators of those variables, and the people who are the intended beneficiaries. The challenge is not only to evaluate the performance of any project in terms of inputs and outputs delivery, but to assess the added-value of an integrated project approach, which hinges on the interactions and synergies

among the institutional, social, economic and technical driving forces to reverse or prevent a trend in soil and environmental degradation of a specific watershed.

In Maharashtra alone drought history reveals that the state will face graver crisis in near future. The rainfall availability of monsoon in Maharashtra is sliding down from days to hours and therefore meeting with water scarcity is the biggest challenge. The picture of rainfall in Maharashtra is given in following Table 1.1 (Vinchurkar S.S, 2021).

Division	Average Rainfall in mm	Average Rainfall monsoon mm	Rainy days	No. of hr in which 50% Rainfall available
Kokan	2829	2700	84	40
Madhya/Western Maharashtra	998	770	40	16
Marathwada	838	650	37	16
Vidarbha	1101	950	45	18
Maharashtra	1441	1267	51.5	22.5

(Courtesy: – Meteorological stations, IMD & presentation on water resources by Abasaheb Haral, Director, National Horticulture Mission, Pune-2008)

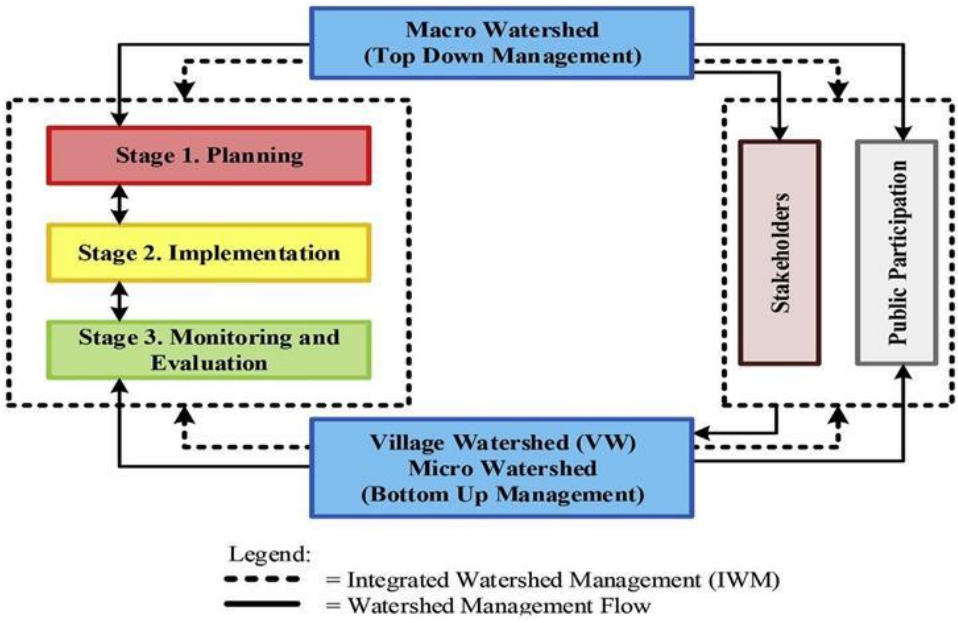

Fig1. Framework of integrated watershed management (IWM)

(Courtesy: - Watershed management index based on the village watershed model (VWM) approach towards sustainability (2020)

REVIEW ON WATERSHED MANAGEMENT

(Patil S. G. 2013) Demonstrates that in affected areas ground water quality has also become saline therefore rendering it unsuitable for the irrigation. The formation due to poor storage and transmission characteristics get fully saturated during the monsoon and a situation of rejected recharge is resulted. As a result, the dug wells become dry by the month of February onwards. As large amount of ground water is drawn out from underground reduction of groundwater table which is turn reduction water level in wells. To cathect is problem of water storage in rural areas, the technique of watershed management is best suited. This method is cheap and also provides employment to villagers. It also reduces soil erosion and also facilities plantation of trees or fodder which is beneficial to the farmers. Hence watershed management is good technique to solve problem of water in rural areas and also increase the revenue of rural population.

The conserving water is not only our duty but is also a necessity for the survival for the present and future generation. The area which mainly depends on groundwater and having very less surface water resources are continuously using the water by pumping leads to decline of water table as well as quality. In India especially western Maharashtra the most important issue is the shortage of water in the villages for drinking as well as agriculture and other purposes. Due to continuous drought, there are many cases of farmer suicide. Thus, management and conservation of water are much important in these areas. The annual average rainfall is also very less but can be used with the help of groundwater recharge technics and harvesting. Living standard and economic condition for people of khor village will improved by implementing watershed management There is no perennial source of water for drinking and irrigation in khor village. 1200850-meter cube water is available for recharge of the total rainfall 410mm annually. By studies, it is found 94.69% of water can be recharged by constructing water conservation structure. Proposed structure like farm pond, check dam, vanrai bandhara and roof top rainfall harvesting will be useful for counter the situation the dry period as well as drought like situation Living of standard and economic condition of people of khor village will improved by implementing watershed management. (Singh Manchand, 2017)

The study performed that in the head reach, the rise of groundwater table is more as compared to the lower reach. The main factors that contribute to the drainage congestion are I. Faulty irrigation and water management practice; II. Intensive rice-rice cultivation; III. Plot to plot irrigation in rice field instead of using field channel; Iv. Continuous canal flow V. excessive seepage losses in the canal system etc This has caused serious problem of water logging in the command, especially in the head and mid reach of the command, the main cause of water logging in the command are faulty water management practice; intensive rice- rice cultivation; Absence of field channels to irrigate the field; no rotational irrigation system; no control over flow i.e. absence of volumetric measurement device to measure and supply irrigation water; no crop diversification; drainage congestion in outlets; unlined/badly maintained channels causing major seepage losses in canal system; mismatch between the demand and supply system; lack of land development and inadequate drainage facilities; plot to lot irrigation. The paper discusses the various pertinent issues regarding the water logging problems in the hirakund command of Odisha. The experimental finding reveals that parallel field surface drains at 10m drain spacing is effective to control the rising groundwater table in the command table in the command which will facilitate in lowering the water table and growing non rice crops in the command. (Raut Pradeep Kumar, 2017)

A study of a watershed development model from differing physical and social-economic frame work reveals the variability in the nature and degree of impact of watershed development on drinking water regimes from various agro climatic regimes of India. In the process of EIA, the formulation and implementation of an EMP lays the framework for continued assessment of potential impacts through the application of monitoring and auditing. The result is that potentially negative impacts can often be avoided and almost always reduced, without compromising the real cost of project. Collection of baseline information for assessment of impacts collation of information collected during previous investigations in to one comprehensive environmental document. Assessment and evaluation of the actual and potential environmental impact of the proposed development of costed and resourced environmental management and monitoring, plans to identify mitigation strategies targeted towards avoidance,

minimisation and rehabilitation of impacts. The project moreover requires an effective environmental management plan (EMP) the EIA and post construction stages of the project. (Dr. Sharma A. K. 2014)

This research paper emphasis on past data of water resources management shows the necessity of the watershed management at micro level implementation proper management of institutional authorities they are failed to maintain the socio economically growth and life style of the community. During survey some suggestions for these problems are also suggested by some peoples, that was water supply schemes some people says that warana river is very close to village so it is possible to take water from this source but government authority was ignoring. Ground water in this area is used for drinking purpose and also for the irrigation purposes. It was found that water quality of ground water is contaminated by unhealthy metals like nitrate, iron, fluoride etc. Which can cause very critical health issues in future so it is observed from this study is ground water is contaminated so it can be used for the drinking and domestic purposes and so it can be used for the agricultural purposes and for drinking water there is need of sustainable drinking water resource lift irrigation scheme which was earlier suggested by many of peoples in this area while taking their interviews so far sustainable drinking water resource water supply scheme is strongly recommended and it is very essential to recharge the ground water so far that roof rain water harvesting, farm pond, check dams, vanrai bandhar and contour trenching these all possible measures are to be implemented in future for the sustainable water resources. If this all measures are implemented successfully then socio- economic condition of the peoples in this area will be improved significantly. (Pandas Punashri 2015)

In the literature Managing watersheds is a comprehensive integrated and holistic management process that seeks to balance in socio-economic and natural resources base within watersheds. Loss of stream base flow and un sustainability of the production system. Management of soil-water-forest resources has been a common agenda of all the projects and according to the environmental, social, economic or national demands some other strategies out of ten reputed strategies have been used. Watershed is a drainage area from which the entire run-off drains towards a single point. Watershed is not simply as the role in determining food, social and economical entity which plays a crucial

support service to the rural people. Watershed management is an adaptive, comprehensive, integrated and holistic management process that seeks to balance healthy ecological, hydrological, economical, and social conditions within watershed. Collected project information analysed through summarizing, tabulation, comparison calculations and rational explanations. Watershed management is a comprehensive, integrated and holistic management process that seeks to balance, socio- economic and natural resources base within a specifically identified geo-hydro-ecological unit. (Perera M. P. 2016)

The importance of employing integrated watershed management strategies and has outlined numerous methods for improving management strategies, such as incorporation of new technologies and models, inclusion of holistic and adaptive management strategies, stakeholder participation, cross-jurisdictional partnership, and the consideration of climate change impacts in management planning. This evaluation of integrated watershed management and presentation of tools and strategies to improve sustainable watershed management represents an important synthesis of knowledge for scientists, stakeholders, resource managers, and government agencies. Our work can be used to improve agencies' management strategies and better the ecological and socioeconomic conditions within watersheds of concern. By employing the steps outlined for developing and maintaining watershed management strategies, integrating appropriate technologies and resources, and gleaning lessons from the case studies presented, future watershed management applied to any circumstances and location may be improved and more successful achieve ecological, social, and economic management objectives. (Guangyu Wang, 2016)

The researcher studies an overview of various techniques like farm ponds, check dams, vanrai bandhara etc. Which are suggested to overcome the problems related with reducing runoff amount after implementation of IWMP. Watershed management involves the judicious use of natural resource with active participation of institutions, organization, in harmony with the ecosystem. Watershed development programme in India envisages promotion of multiple objectives. The technical objectives of the programme to control runoff and degradation and there by conservation of soil and water. To utilized the runoff water

for useful purpose. To protect conserve and improve the land of watershed for efficient and sustained production. To check soil erosion and to reduce the effect of sediment yield on the watershed. To increase infiltration of rainwater. To enhance the groundwater recharge. (Ronge P. M. 2017)

Types of Watersheds

There are generally five level of watershed based on geological area of the watershed viz;

1. Micro Watershed	>50,000Ha
2. Sub-Watershed	10,000 to 50,000Ha
3. Mili-Watershed	1000 to 10,000Ha
4. Micro Watershed	100 to 1000Ha
5. Mini Watershed	1-100Ha

The conducted methods highlight the fact that life and policy sub-indicators of the global index need to be replaced for the Romanian river basins; the hardest decision in this regard was the establishment of the correspondents for per capita income and the basin institutional capacity in integrated water resource management. Therefore, new contributions prove their significance in the methodological advancement by the adaptive sub-indicators for each case study, depending on its features concerning demography, education level, and stage of development. Even though the research deviates from the classic formula of the Watershed Sustainability Index, by bringing to the same final value, comprised between 0 and 1, the employed method does not affect its application and provides comparative capability across cases. (Oana Mititelu-Ionuș, 2017)

The researcher studies an overview of various techniques like farm ponds, check dams, vanrai bandhara etc. Which are suggested to overcome the problems related with reducing runoff amount after implementation of IWMP. Watershed management involves the judicious use of natural resource with active participation of institutions, organization, in harmony with the ecosystem. Watershed development programme in India envisages promotion of multiple objectives. The technical objectives of the programme to control runoff and degradation and there by conservation of soil and water.To utilized the runoff water for useful purpose. To protect conserve and improve the land of watershed for efficient and sustained production To check soil erosion and to reduce the effect of sediment yield on the watershed. To increase infiltration of rainwater To

enhance the groundwater recharge.(Ronge To find out the technique of water conservation which will sustain in rural areas and to compile the results by applying the model which will work for this The structures included gully plugs on existing water stream followed by the farm pond at its end along with farm terrace and continuous contour trenches surrounding the water stream. Watershed management tries to bring about the best possible balance in between the water resources on one side and human and other living beings on the other, improving the socio-economic status of the villagers. In the present study, for calibration and validation, conventional method along arc SWAT tool was used. The main function of interface to provide a link between the input/output of a calibration program and the model The simulation with the provision of farm ponds in all the sub basin proved to be satisfactory for soil conservation. SWAT model proved to be the effective tool in computing the impact of changes in land management and climate on runoff and sediment yield. If implemented on a field scale, the SWAT model can be used in the future, as a guide for the farmers at an individual level for finalization of the best management practices for soil and water conservation for their farms. (Swami V. A. 2018)

P. M. 2017)

In Ingrul village, there is water scarcity during months of February to May for drinking as well as for irrigation. Population of Ingrul village is increasing rapidly. The annual average rainfall is also not sufficient. It is found that 81% of this available water can be recharged in watershed area for Ingrul village. Total cost of rainwater harvesting structures is 1,00,15,450 rupees and it can be easily managing by individual basis by villagers. It will effectively solve problem of drinking water and domestic use. Various watershed measures like farm pond, check dam, vanrai bandhara, should be implemented to cope up with the drought conditions. With the help of GIS software location of watershed structures are easily located. Maintenance programme for water storage structure should be done regularly like removing silt in the wells and check dam it will result in increased water storage capacity of above structures and increase ground water table. Growing of cash crops, use of drip irrigation, awareness camps regarding agriculture, irrigation as well as government schemes and subsidy schemes will benefit the farmers of Ingrul village. Perennial source of water is not available to fulfil the requirement. If watershed development

techniques are implemented, it will result in increase in the living standard and economic condition of people of Ingrul village. 8) GIS is effective tool for watershed management. (Patil Snehal S, 2019)

The paper presents an overview of the WSM in relation to land and water care, its growth, approach to people's involvement at different stages of WSM programmes, planning and community organization, monitoring and impact evaluation and sustainable issues in WSM programmes. The paper also presents some policy issues and future challenges as regards to watershed management. The declining per capita land and fresh water availability coupled with soil erosion and land degradation in India are posing serious threat to environmental, food, social and economic security. For sustainable development, land and water should, therefore go together as land and water care constitutes the very foundation for building evergreen revolution in the country. It has also been amply demonstrated in India and elsewhere that it is impossible to envisage or implement sustainable solutions for land and water resource development and management without active and full participation of civil society. Watershed management (WSM) has emerged as a new paradigm for planning, development and management of land, water and biomass resources with a focus on social and institutional aspects apart from bio-physical aspects following a participatory "bottom approach". Watershed programmes are being implemented under an array of national schemes/programmes. The encouraging results and the experience of various integrated watershed management programmes in the country strongly suggest their importance and technical, economical, social and environmental viability for sustainable development through people's participation. (Sikka A. K, Sharda V. N. 2020)

In this paper reveals that Watershed is not simply the hydrological unit but also socio- political-ecological entity which plays crucial role in determining food, social and economical security and provides life support services to rural people. The criteria for selecting watershed size also depend on the objectives of the development and terrain slope. In hilly areas or where intensive agriculture development is planned, the size of watershed relatively preferred is small. Watershed development program is therefore, considered as an effective tool

for addressing many of these problems and recognized as potential engine for agriculture growth and development in fragile and marginal rain-fed areas. Major objectives of the watershed management program are. From the hydrological point of view, the different phases of hydrological cycle in a watershed are dependent on the various natural features and human activities. Watershed is not simply the hydrological unit but also socio-political-ecological entity which plays crucial role in determining food, social and economic security and provides life support services to rural people. Adopt holistic and participatory consortium approach from the beginning i.e., from selection of watershed. Ensure that ground rules for operation are made clear to the community as well as consortium partners. Adopt knowledge-based entry point approach to build rapport with the community and ensure tangible economic benefits for the community. (Wani Suhas P. and Garg Kaushal k, 2021)

The case study presented here suggests that the evaluation of agro-ecological characteristics from primary data, soil erosion assessment and aspects of conservation management, could lead to the generation of a WATMIS for a watershed. Future demand demands for sustainable of the watershed can be formulated based on which thrust areas in each sector can be identified, the raster-based GIS provides an easy method of integrating the watershed resource data in to useful maps. The study also ensures the ability to monitor the dynamic, changes of the watershed particularly the land-use pattern, by remote sensing at periodic intervals, and to redefine the conservation planning strategies on the basis of detected change. Although it is an early airing of results obtained from the methodology described, the introduction of multidisciplinary experts informed opinion may provide an extension to the traditional methods of watershed management programs that should enable us to generate and/or evaluate different conservation scenario. (Adinarayan J. 2021)

The Watershed development and management projects receive low priority because of unattractive direct benefits reflected in traditional type of cost-benefit analysis. Inconsistency is found in the basic framework of programmes, including activities implemented in different watersheds of the same country. Watersheds bear significant importance from ecological, aesthetics and socio-economic perspectives. Due to the lack of comprehensive macro-level studies, no

conclusions can be drawn about the status of watersheds on a regional scale. However, findings of several micro-level studies indicate that watersheds are undergoing soil erosion, soil nutrient depletion and deforestation, though the extent of these problems varies from one area to another. (Thapa G. B. 2021)

This project is more efficient and effective when user is given a role in managing their own watershed resources. Major challenge in watershed is assumption of technology transfer instead of development of technology on peoples training land and their surroundings. Realizing this participatory watershed management has emerged as a new paradigm for watershed development in India. This improved soil moisture will open new opportunities for diversify farming activities in rainfed areas. Participation of local community was central to this approach and community participation will be encouraged by various communities. This study was based on the metanalysis and the authors made an attempt to evaluate the watershed program and people participation. Evidence from case studies general impact studies suggests that watershed development brought several positive trends including diversification of rural economy, development of new institution, increasing cropping intensity, improved fodder, production increase availability of drinking water with rising ground water table, capacity development of community. (Yoganda B. 2006)

The Watershed management is not so much about managing natural resources but about managing human activity as it affects these resources. Effective watershed management can prevent community water storages, poor water quality, flood and erosion. The expense of undertaking watershed management is for less than the cost of future remediation. For development of agriculture and drinking water resources the basic elements required are land and water construction of large dams, water intensive cropping patterns, neglect of local water systems and unaccountable water management are to blame for this unprecedented situation. Through watershed the available rain water can be usefully led to recharge resources or directly store and use it during the water scarcity y. Hilly terrain in N-W side and average slope of ground is towards east. It is observed that natural flow lines of the terrain and helps in the analysis of watershed in the area. Slope direction, topography, hill is very important factor is useful for analysis and decision-making

watershed area. For successful implementation of this project participation of local people government officers, and funding agencies is must. As these techniques are eco-friendly the development due to this in future will be sustainable. (Jankar P. D. 2013)

STUDY OF SOIL AND LAND EVALUATION

It Demonstrate that the result obtained by land evaluation methods indicate the information on production potential of soils, which study area were classified in to capability II, III, IV and VI. It relates to soil and water conservation and leads to proper land use as per the capability or suitability of soils, protection of land against degradation, Maintenance of soils fertility and increasing productivity from all land uses. The morphological characteristics of the soils showed that most of the soil were shallow too deep with color in hue 10 year, this may be due to the sweal shrink phenomenon of clay observed in such soils resulting in the development of slickenside most of the day in texture with clay content ranging from 34.4% to 73.4% This land resource development plan will help in efficient management of the potential yield on a sustainable basis and for efficient soil based agro technology transfer for better harvest of pigeon pond on similar soils under similar agro climatic condition else were. (Gabane V. V. 2006)

A study was conducted in the Pokhara khola watershed of middle mountain Nepal to evaluate the effects of land use and cropping patterns on soil properties, soil nutrient reserves soil quality. Interview were conducted to understand farmers assessment of soil quantity was influenced by crop yield and economic profitability. Therefore, there is a need to develop criteria to evaluate soil quality and to take preventive and restorative measures to improve mountain farming. The study revealed that farmers believed quality of soil influenced economic profitability in terms of high yield and immediate return. The quality and quantity of FYM / compost material should be increased by utilizing locally available compost materials to improve soil quality and mountain sustainable upland farming. This study concluded that the soil property assessment should be linked to farmers perception and circumstances to provide a realistic approach to soil quality and develop sustainable land management in mountain farming would be difficult. (Tiwari K. R. 2006)

It studies area is dore lake situated in the kumarswamy layout, bangalore (560078) and the identification of sediment source area and prediction of storm sediment yield from catchment area or soil erosion occure in that area for measure that a GIS is proposed. Soil erosion is a naturally occurring process that affects all landforms. Soil erosion is one of the most critical environmental and most frequently hazards specially in mountains and hilly areas of modern times which occur in any catchment area. Hydrology, topography, soil surface cover, residual land use, surface effects, tillage marks are the major factors that affect unplanned erosion processes. The information taken by sources of sediment yield within a catchment can be used to check the rate of soil erosion occurring within that catchment. Land disturbing activities, trenching, clean fills and runoff diversion channel are some methods to reduce soil erosion. Sediment retention pond, chemical flocculation system, silt fence and sump/sediment pit are some methods to reduce sedimentation. There is reduction in soil erosion in the watershed areas. However the variation in the percentage of reduction primarily dependant on quality of soil and moisture conservation activities in the respective areas. It is observed that the programme is mostly successful in maintaining runoff reduction. Sediment yield is more related to current soil condition than to the erosive capacity of the rain. Some tests on sample have done for drinking purpose. But we got turbidity more than 5NTU which implies not suitable for drinking purpose. Hence use for irrigation purpose. (Talageri A. M 2021)

It Reported that the data related to soil slope length and steepness, crop management and conservation measures were derived from satellite data, toposheet and ground truth survey and used as inputs in USLE model for assessment of erosional soil loss. Satellite remote sensing provide scientific input for faster and precise mapping of natural resources and degraded / eroded lands and also facilitates for quick evaluation of vegetation status vital for erosion assessment. Considerably about their means with the intensity of rainstorms. But the effects of these random fluctuations tend to average out over long periods. In the present study the value of ‘C’ for different land use classes were extracted from the published literature. The most important of these supporting practices are contour cultivation, strip, cropping, terrace system, bunding and water way for the disposal of excess rainfall. (Karche V.K. 2012)

PEOPLE'S PARTICIPATION IN WATERSHED

It was observed that most watershed projects did not address the equity issues of benefits, community, participation, scaling up approaches monitoring and evaluation. Application of integrated, cost effective, soil water nutrient management practices appropriate to farmer resources and the natural resources of the eco-system. Refinement of technologies and on farm strategic research experimentation by farmers with technical support from the consortium partners Scaling up method and models monitoring and evaluation of the impact of watershed interventions holistic approaches in the technical support to most development projects implemented by NGO's using the baseline survey of the village and a detailed reconnaissance survey of the watershed the watershed committee identified sites for soil and water conservation structures and other measures. For reduction of runoff and soil loss the soil and water management measures in the treated watershed included field building, gully plugging and check dams across the main water course along with improved soil water nutrient and crop management technologies improve ground water. There was a significant improvement in the yields of the most wells, particularly those located near check dams. (Singh S. P. 2003)

In watershed management people's awareness participation and response is of at most importance in improving the economy of farmers. Watershed management is meant for growing biomass, the pipeline for prosperity of the people for bridging the gap between poverty line and per capita income. The other points of interest in awareness are through understanding of all aspects of the subject modification of the same suiting to the region and locality vis-Avis the local peoples wish tastes and background and simple communication with patience interest and sincerity to achieve the purpose of making them understand. As government scheme reasons, we have to give more stress on collective efforts of local people by demonstrating the same of them system management, team work appreciation of new ideas though simple respect for good old value of hard work and integrated approach leads certainly to great success in watershed management. (Dr. Mrs. Kulkarni S. S, Mrs. Swami V. A. 2012)

A detailed structured three- point-continuum schedule was development by the investigators regarding various aspects

of participation by local people in soil and water conservation for the watershed management programme. People's participation index (PPI) was also designed to compute the extent of people's participation Verhaegen was the opinion that "participation is generally presented as the active involvement of target groups in planning, implementation and control programmes and projects and not merely their passive acquiescence in performing predetermined tasks not merely their exploitation in order to reduce the labour cost. The study was taken with the main objective to find out the extent of people's participation in government sponsored watershed development programme in the Vidarbha region of Maharashtra.

A structure schedule for data collection was developed by the investigator to access the extent of people's participation in the watershed development programme. In implementation stage, majority of farmers for labour and money contribution towards construction of soil and water conservation structure in their fields and also asked their fellow farmers for labour and money contribution toeards construction and conservation structures in their watershed area. (Bardi G (Bardi Gopal lal, Kurothe R. S. 2014)

WATER RESOURCE MANAGEMENT

The main objective of the study is to examine the perceptions of water resource management by the selected farmers in the study area. To map out the significance of water resource management on paddy cultivation in the study area The relevant data collected from primary survey. The study was conducted in Nagapattinam, Mayiladuthurai, Tharangambadi, sirkali taluks of Nagapattinam district of tamil nadu. The study choosen 480 samples for the study Almost 76% have familiar with the modern practice of cultivation and water resource management, 78.9% revealed lack of irrigation is the important determinant of paddy cultivation, 79.3% familiar with check dam, cleaning of canals, preservation of tanks and distilling the water resources to preserve the irrigation facilities for paddy cultivation in the study area. The study area also utilized correlation to map out the significant connection between water resource management and area under cultivation for paddy cultivation. The significance value implies that probability of the correlation is high. Therefore, it could be inferred for the outcome that the correlation between effective water resource management expand the scope for area under cultivation as the proper irrigation facilities enhances the area under cultivation thereby enrich

production of paddy across the study area. Revolution in cropping patterns, advanced cropping and farming methods, proper warehousing and marketing facilities help the farmers look beyond this sector as a profit-making industry. Thus, optimum utilization of the available scared water found to be crucial element in paddy cultivation. (Subramaniasiva V. 2020)

From the findings of our study, watershed management towards sustainability can be achieved if there is integration between natural, institutional, technological and financial resources. It was found that in terms of village watershed management, the village government felt that watershed management was mandatory and had formed an institution, to carry out water conservation activities or improve the environment by using village funds. The impact of water conservation activities by communities that use village funds is shown; among others by constructing redrain ponds (water storage). This can increase farmers' crop yields. Watershed management based on the VVM approach can also be used to determine the strategy for handling watershed repairs. Handlers should start from the upstream watershed (Village watershed), and then integrate between downstream and upstream, so that the results are optimal. Besides that, all stakeholders are involved in integrated watershed management both from the Central Government (Centre for Watershed Management, Central River Basin), Central Java Provincial Government (Office of Water Resources and Spatial Planning, Office of Environment and Forestry), Management Coordination Forum Central Java Province Watersheds, and Private Parties, etc. It was observed that integration and sustainability in the watershed based on village watershed management (VWM) had weaknesses. If there is no watershed management technician in the village area, or if village funding from the central government is stopped, then assistance from relevant stakeholders (Watershed Forum) or other funding sources is needed. (Ignatius Sriyana a, DeGijt b J. G, Sri Kumala Parahyangsari c, John Bosco Niyomukiza 2020)

Determination of Indices

A set of indicators evolved to analyse the impact of watershed and sustainability attributes has been presented. The indicators would provide a sound and scientific basis to critically evaluate the impact of agronomical, biological and engineering measures on improving the productivity of arable and non-arable lands, socio-economic status of the

watershed community and ensure environmental stability in the long run. They would also help in economically justifying the expenditure on various activities in the watershed development programmes involving huge investments in the country. The evaluation of such programmes through the developed indicators would also bring greater transparency and accountability towards the people and also inculcate better confidence among the implementing agencies. The indicators would also facilitate comparison of various watershed development projects executed by different developmental agencies in terms of performance and impact more scientifically and systematically across the watersheds within the state, in the region and the country as a whole. Though some of the indicators have been tested and evaluated under field condition in selected watersheds by the authors, they need to be adopted and evaluated on a wider scale representing different climatic, physiographic, edaphic and socio-economic conditions in the country to realistically assess the performance of watershed development programmes and their inter-comparisons. Moreover, the developed indicators only pertain to tangible benefits. Enough scope exists to develop more indicators in the near future to account for intangible benefits and some other tangible benefits, which may not have been covered in the present study. (Pradeep dogra 2012)

The aim of this study was sustainable development in the Indla-Ghatkheda watershed area through soil and water conservation activities. Increase in irrigation due to watershed development activities indicate that according to majority of respondent, there is enhancement in socio-economic status due to watershed development activities. Increase in soil facility due to watershed development activities it indicates that according to majority of respondents, there is increase in soil fertility due to watershed development activities. Increase in water table due to watershed development activities indicate that according that to majority of respondent, there is increase in water table due to watershed development activities. Activities proposed by farmers in the watershed. It indicates that majority of respondents strongly proposed loose boulder structure, TCM and plantation activities in the study area along with farm pond with vertical bore, Gabian structure, WAT, CCT and dryland horticulture activities. Very few respondents proposed the repair of existing CP. It felt that if the above treatment is implemented more

ground water will be available for irrigation and additional fodder for the cattle's will be available from the wasteland. The water conservation aspect and development in watershed area through soil and water conservation seems to be achieved w.r.to sustainable development. From above study and data obtained from field observation, it is concluded that sustainable development in the watershed area through soil and water conservation activity is mostly achieved. (Vinchukar S. S, Dr. Ingole N. W. 2012)

Management Indicators:

$$\text{Land Levelling Index (LLI)} = \frac{\text{Recommended slope (\%)}}{\text{Existing or treated slope (\%)}}$$

Socio Economic Indicator:

$$\text{Critical Area Index (CAI)} = \frac{\text{Benefited critical area from structures}}{\text{Total critical area}}$$

$$\text{Poverty Index (PI)} = \frac{\text{Number of BPL families}}{\text{Total Number of families}} \times 100$$

Regular Employment Generation index:

$$\text{Regular Employment Generation Index (REGI)} = \frac{\sum_{i=1}^{n} Ei\ X\ A\ i \text{ (After the project)}}{\sum_{j=1}^{k} EjXAj \text{ (before the project)}} \times 100$$

$$\text{Irrigability Index (II)} = \frac{\text{Additional gross irrigated area}}{\text{Net incremental irrigated area}}$$

Human development index:

$$\text{Height for Age Coefficient (HAC)} = \frac{\sum_{j=1}^{k}\sum_{i=1}^{n} Observed \text{ hij}}{\sum_{j=1}^{k} \text{fj x Recommended hj}}$$

Sustainability Indicators:

$$\text{Runoff Conservation Index (RCI)} = \frac{\text{Runoff water conserved in the watershed after the project}}{\text{Runoff water estimated before the project}} \times 100$$

$$\text{Soil Erosion Risk Index (SERI)} = \frac{\sum_{i=1}^{n} \text{Permissible soil loss } \left(\frac{t}{ha}\right) \text{as per soil loss tolerance limit in the ith homogeneous unit of watershed}}{\sum_{i=1}^{n} \text{prevailing soil loss } \left(\frac{t}{ha}\right) \text{in the ith homogeneous unit of waste water}}$$

$$\text{Induced watershed Eco-Index (EWEI)} = \frac{\text{Additional area vegetated during the project}}{\text{Total area of the watershed}}$$

$$\text{Carrying Capacity Index (CCI)} = \frac{\text{Quantity of fodder available}}{\text{(No of standard livestock units) X (Standard requirement of green fodder per livestock unit)}}$$

$$\text{Participatory Watershed Development Index (PWDI)} = \frac{\sum_{i=1}^{10} \text{Weighted Score}_i}{\sum_{i=1}^{10} \text{Maximum weighted Score}_i} \times 100$$

$$\text{Participation paradigm Index (PPdI)} = \frac{\text{Weighted Score}}{\text{Max Weighted Score}} \times 100$$

In this paper told that People participation is a dynamic group process in which all members of a group contribute towards the attainment of groups objectives share the benefits from, groups, activities, objectives, share the benefits from groups activities exchange information and experiences of common interests and follow rules, regulations and other decisions made by the group. For achieving the desired participation of people involvement of community, organizations, groups and other stakeholders are crucial. The quantitative importance of the explanatory variables can be ascertained by the marginal effect. Which was calculated by different the probability equation with respect to the particular explanatory variable (dpi/dxi).the whole process of watershed development programmes was classified as four stages i.e, programme planning, programme implementation, programme maintenance (pm) and programme monitoring and evaluation. The probability of the farmers participatory outcomes is greater probability of the farmer in reference category for re-classification of the variable from zero to one or two. Beyond the formal arrangements several informal approaches are necessary to enhance voluntary participation of people in programme effectively which will ensure the success and sustainability of watershed programmes. (Mondal Biswajit, Singh Alka, I. sekar 2013**)**

During the study it is revealed that additional treatments suggested for the watershed area are graded bund, loose boulder structure, gabian structure cement plug, field trench, Dry land horticulture, Farm Pond and plantation along with new treatment like WANT and gully plug have recommended for better results. The aim of the study was study and evaluation of impact of soil and water conservation treatments on selected watershed area. From collected data it indicates that graded bund, loose boulder structure, plantation treatments exist in large scale in the study area along with dry land horticulture, field drain. But existence of gabian structure and cp activity is very low. From the study of data, we found that water table gap is widening between watershed development program implemented areas and non-implemented area. Since ground water level has come up more area has come under irrigation and drinking water problem in all the three villages has been adequately solved. From the above study and data obtained from field observation, it is concluded that sustainable development in the watershed area through soil and water conservation activity is mostly

achieved. (Vinchurkar S. S, Dr. Ingole N. W. 2016)

In this study, the Geo-Statistical algorithm of RUSLE equation investigated to measurement of soil loss in the study area. This makes understanding on GIS capability in soil loss modelling.

Estimation of soil loss is prime factor to compute sediment yield in watershed and catchment level studies Out of total area 7.3 Sq. Km area have soil loss range is less than 0.20 tons per ha/ per year categorized as very low erosion area. 6.4 Sq. Km area have soil loss range between 0.21 to 0.45 tons per ha/per year. 3.1 Sq.km area have soil loss range between 0.46 to 0.84 tons per ha/per year. Approximately 1 Sq. Km area have soil loss range between 1 ton to 4.56 tons per ha/per year. (Ingole N. W. and Vinchurkar S. S. 2021)

Evaluation of impact on watershed by using different indices was carried out to evaluate the watershed performance of Indla-Ghatkhed watershed. It was observed that the farmers in indla-Ghatkheda watershed have participated moderately in the watershed development programme planning and implementation stages, whereas high level of participation was exhibited by farmers in maintenance stage of watershed development programme. The first step in this knowledge-collecting process is usually the classification of the soils according to their morphology. Morphology characteristics of soil reflect soil genesis and are interrelated to other chemical physical mineralogical and biological properties. Morphological properties are commonly used as a substitute for more meaningful properties that are seldom measured on a routine basis. Employment generation has come to occupy centre stage in research and development planning as well as implementation in many developing countries. It results in out-migration of young and healthy rural workforce to sub-urban and urban areas.

Based on the observations, survey and various indicators there are some conclusions to be justified. The land levelling index in Indla-Ghatkheda watershed attains maximum value of 1.0 which refers to perfectly levelled field. The critical area index reported in Indla-Ghatkheda watershed is 0.85 which nearly equal to ideal value 1.0. It means critical area benefited due to the watershed treatment is maximum indicating the biomass production is increased. The reported value of Irrigability Index is 1.39, Which proved that irrigation status of

village is good and improving. All the indices except soil loss and induced watershed eco index were found satisfactory. Hence following recommendation were suggested for these two indices, untreated area should be identified and appropriate treatment should be implemented to reduce soil loss. (Vinchurkar S. S. Dr. Ingole N. W. 2021)

In This paper presents one such case study where large amount of rainwater is possible to direct to recharge ground water resources. This will also help us for economical development of village people which mainly occur due to water scarcity.

Watershed management arrests the soil erosion, reclaims vast tracts of eroded lands. Improve soil moisture, harvests rainwater in small ponds or tanks reduces floods recharge groundwater and revives greenery. There is constructed that watershed management technique on 0.25 ha. The main crop production from this farm is rice and groundnut. Data from respondent the impact of watershed management, there is considerable improvement in the irrigation status.

For calculating per capita income the value of each crop is considered according to current market price at the time of study before and after situation. Thus, finally conclude that economical development of village people possible through watershed management. (Kumbhar Vishal 2013)

The precision of land levelling may depend upon the volume of the earthwork in the cut or fill with reference to the desired plane in an area. The term land levelling index (LLI) is used to represent levelling quality quantitively. The land levelling index as the average numerical variation between the proposed or designed levels and existing average field levels either before or after the completion of levelling works It expresses as. (Yaligar Ravindra 2017)

$$\text{Levelling Index} = \frac{\text{Numerical difference between the design land existing grid level}}{\text{Number of grid point}}$$

CONCLUDING REMARKS

From the observation and analysis researchers following conclusions appear to be justified. It is felt that above treatments are implemented more ground water will be available for irrigation and additional fodder for the cattle's will be available from the watershed. From the above study and data from indices it concludes that:

LLI can attain a maximum value of 1.0 which refers to a perfectly levelled field. Irrigability index can attain any value more than 0, and a higher value will indicate successful utilization of harvested water in the watershed management project. The CAI can attain a maximum value of 1.0 and a higher value of CAI is a measure of better treatment of the critical area. Poverty index can have a value ranging from 0 to 100, and it can be utilized in PrP and PoP scenario to assess the change in number of poor stakeholder families within the watershed. Regular Employment Generation Index can attain any positive value and any value higher than 100 will indicate the percentage of improvement in regular employment leading to reduction in outmigration under ceteris paribus condition. The value of HAC can vary between more than 0 to 1 The value of RCI may vary from 0 to 100 and a value of 100 denote that the entire runoff from the watershed in the PrP period has been intercepted and conserved within the watershed in the PoP scenario. The value of soil erosion risk index can vary 0 to 1 and in some case even higher, Higher value of SERI is a measure of a better moderation in soil loss, whereas a very low value near to zero indicates that the watershed is suffering from a soil loss significantly more than its permissible limit and is at risk of degrading. IWEI can attain a maximum value of 1.0 which indicates that whole of the treated water area has been brought under some form of a vegetation. The carrying capacity index is a suitable indicator which is the ration of the quality of fodder available and required for the existing livestock population. The value of index varies from 0 to 1. Participatory watershed development index and participation index can have values ranges from 0 to 100 and higher value will indicate that higher numbers of the participatory aspects of the programmes have been executed

ACKNOWLEDGEMENT

The author is very much thankful to Principal Dr. A. P. Bodkhe and Dr. P. S. Pajgade, Head Department of civil Engineering, PRMIT&R Badnera, Amravati. For their fullest cooperation also thank to Co-guide Dr. S. S. Vinchurkar sir for comments that greatly

improved the manuscript. I would also thank to class teacher Prof. Sachin Dharpal for timely guidance guidance. And warm thanks to college librarian to permit us of research papers online and manually.

REFERENCES

1. Adinarayan J. (2021): "A System-Approach model for conservation planning of a hilly watershed". Journal of Environmental Management, 44, pp 375-384
2. Bagdi Gopal lal, Kurothe R. S. (2014): "People's participation in watershed management programmes evaluation study of Vidarbha region of Maharashtra in india". International Soil and Water Conservation Research, Vol. 2, No. 3, 2014, pp. 57-66
3. Dogra Pradeep, Dhyani B.L, Sharda V.N. (2012): "Indicators for assessing the impacts of watershed development programmes in different regions of India". Vol. 40, No. 1, pp 1-12, 2012 Indian Journal of Soil Conservation Online.
4. Dr. Ingole N. W. (2021): "Evaluation of Impact on watershed by using different indices" of indla-Ghatkhed, District- Amravati, Maharashtra. Journal of Water Resource Engineering & Pollution Studies Volume 5 Issue 2
5. Dr. Ingole N. W. and Vinchurkar S. S. (2021): "Assessment of Soil Erosion by RUSLE Model using Remote Sensing and GIS of Indla-Ghatkhed, District-Amravati, Maharashtra". International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) Volume 4, Issue 2
6. Jankar P.D, Dr. Mrs. Kulkarni S. S. (2013): "A case study watershed management for madgyal village". International Journal of Advanced Engineering Research and Studies.
7. Kharche V.K. (2012): "Mapping of erosional soil loss in Ridhora watershed of Nagpur district of Maharashtra using remotely sensed data and GIS techniques". Department o/Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidhypeeth, Akola-444 104, India.
8. Sushma S. (2013): "Effectiveness of watershed management- means of economical development- A case study". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,

p- ISSN: 2320-334X, Volume 6, Issue 6

9. Dr. Mrs. Kulkarni S. S., Mrs. Swami V. A, Mrs. Borchate S. S, Mr. Sawant A. B. (2012): "Watershed management through social mapping: A means of community participation." International Journal of Engineering Science and Technology (IJEST) Vol. 3 No. 9
10. Mondal Biswajit, Singh Alka, Sekar I. (2013): "Dimensions and determinants of people's participation in watershed development programmes in Bundelkhand region of Madhya Pradesh an econometric analysis." Indian Journal of soil conservation vol.41, No.2, pp177-184,2013
11. Oana Mititelu-Ionuș (2017): "Watershed Sustainability Index Development and Application: Case Study of the Motru River in Romania".Pol.J.Environ.Stud.Vol. 26. No.5(2017),2095-2105
12. Perera M.P. (2016): "A comparative analysis of recent watershed management programmes of the world." Sri Lankan J. Agric. Sci. Vol. 55 – 2018, 47 – 62
13. Phadnis Punashri (2015): "Water resources management for sustainable development of sadale-modale village Kolhapur". International Journal of Science and Research (IJSR) Volume 4 Issue 8 www.ijsr.net
14. Patil Snehal S, Kulkarni Deepali R, Patil Padmasinh D. (2019): "Watershed Management for Ingrul village in Sangli District, Maharashtra by using GIS".
15. Patil S.G, Abhyankar W.S. (2013): "Watershed management in rural area-case study". International Journal of Scientific Engineering and Research (IJSER) www.ijser.in ISSN. (Online): 2347-3878 Volume 1 Issue 1
16. Raut Pradeep kumar, Panigrahi Balram. (2017): "Development of land and water management plan based on geoinformation technic for puincha watershed, odisha". https://www.mdpi.com/journal/sustainability
17. Ronge P.M, Hangaregekar P.A. (2017):"A case study of integrated watershed management programme at Aapsinga village in Maharshtra". International Research Journal of Engineering and Technology

(IRJET) e-ISSN: 2395 - 0056 Volume: 04 Issue: 04

18. Singh S. P, Pathak T. K, Shiferaw T. J. (2006): "Farmer participation integrated watershed management: Adarsha watershed, kothapally India an innovative and up scalable approach". ejournal.icrisat.org August 2006 | Volume 2 | Issue 1
19. Sikka A.K, Sharda V.N. (2020): "Land and water care through participatory watershed management in India": An overview. 12th ISCO Conference
20. Singh Manchand, Kulkarni Deepali, Talegoankar S.D. (2017): "Assessment of effectiveness, plan and design of watershed management: A case study of khor village, Daund tahsil, Pune District Maharashtra, India". IJSRSET | Volume 3 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099 Themed Section: Engineering and Technology
21. Dr. Sharma A. K, Tiwari Satyendra (2014):"Environmental impact assessment of a watershed project." International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV4IS040939 Vol. 4 Issue 04,
22. Swami V.A, Kulkarni S.S, Thorvat A.R. (2018): "Identification of sustainable option in water conservation for rural India". Aquademia: Water, Environment and Technology, 2018, 2(1), 03 ISSN: 2468-1946
23. Subramaniasiva V. (2020): "Water resource management and sustainable development-with special reference to paddy production in nagapatinam". JETIR March 2020, Volume 7, Issue 3
24. Talageri A.M, Raj R, Nagraja, Shreyash c (2021): "Watershed management system". International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395- 0056 Volume: 08 Issue: 05
25. Thapa G. B. (2021): "Integrated Watershed Management: Basic Concepts and issues".HUMAN SETTLEMENT DEVELOPMENT-Vol. II - Integrated Watershed Management: Basic Concepts and Issues.
26. Tiwari K.R, Sitaula B, Bajrachrya R, Borresen T. (2006): "An assessment of soil quality in Pokhara khola watershed of the middle mountain in Nepal". Journal of Food, Agriculture &

Environment, Vol.4 (3&4), www.world-food.net

27. Thorat MM (2017): "Watershed Management". Int. Res. J. of Science & Engineering, 2017; Vol. 5 (5): 81-83 http://www.irjse.in ISSN: 2322-0015
28. Vinchukar S.S. Dr. Ingole N.W. (2012): "Sustainable development in watershed area through soil and water conservation activities- A case study". International Journal of Scientific & Engineering Research, Volume 3, Issue 12, December-2012 ISSN 2229-5518
29. Vinchurkar S.S, Dr. Ingole N.W. (2016): "Study and evaluation of impact of soil and water conservation treatments on selected watershed area". International Conference on Science and Technology for Sustainable Development (ICSTSD)- 2016, 24 June 2016.
30. Wang Guangyu, Shari Mang, Haisheng Cai, Shirong Liu, Zhiqiang Zhang, Liguo Wang, John L. Innes (2016): "Integrated watershed management: evolution, development and emerging trends". This article is published with open access at Springerlink.com. 30 June 2016.
31. Wani Suhas p. and Garg Kaushal k (2021): "Watershed management concept and principles". International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
32. Yoganand B, Gebremedhin T. G. (2006): "Participatory watershed management sustainable rural livelihood in India". Paper presented at the Southern Agricultural Economics Association Annual Meeting, Orlando, Florida.
33. Yaligar Ravindra, Balkrishnan P, Satishkumar U. (2017): "Land Levelling and its Temporal Variability under Different Levelling. Cultivation Practices and Irrigation Methods for paddy". International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 6 Number 9 (2017) pp. 3784-3789 Journal homepage: http://www.ijcmas.