ASSESSING OF LAND USE LAND COVER IMPACT ON FLOOD IN KEMAMAN RIVER BASIN

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Thesis submitted in fulfillment of the requirements
for the award of the
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ABSTRAK

Perubahan penggunaan tanah penutup tanah (LULC) menjejaskan kitaran dan hasil air ketersediaan hidrologi. Hasil air meningkat sehingga 190% selepas pembersihan hutan untuk aktiviti pertanian di Semenanjung Malaysia. Akses air pulangan boleh menyebabkan banjir di mana-mana kawasan. Objektif utama kajian adalah menilai kesan perubahan penggunaan tanah penutup tanah (LULC) kepada banjir di Lembangan Sungai Kemaman. Bagi mencapai objektif utama kajian, kajian khusus telah dilakukan seperti berikut, untuk menganalisis hujan, evapotranspirasi sebenar (AET) dan lebihan air (hasil air) dan kesan LULC pada banjir di Lembangan Sungai Kemaman. Pada bulan Disember 2014 banjir lebih besar daripada banjir pada Disember 2013. Ini adalah kerana intensiti yang tinggi hujan 1477.8 mm dan 94% (1385.9 mm) dari air produk. Di samping itu, pengurangan dalam LULC vegetatif (11.07% pada 2013-9.11% pada tahun 2014) disebabkan oleh tanaman dan aktiviti penanaman semula yang ditunjukkan oleh pengurangan AET (99.55 mm pada tahun 2013 dan 91.96 mm pada tahun 2014). Daripada penemuan ini, adalah disyorkan skim penanaman semula diambil kira dalam reka bentuk bukan struktur tebatan banjir.

ABSTRACT

Land use land cover (LULC) changes affected the hydrological cycle and water yield availability. Water yield increase up to 190% after forest clearing for agricultural activity in Peninsular Malaysia. Access water-yield could be able flooding any area. The study main objective were assessing of LULC impact on flood in Kemaman River Basin. To achieve the study main objective, the specific study were performed as follows, to analyse the rainfall, actual evapotranspiration (AET) and water surplus (water-yield), and the LULC impact on flood in Kemaman River Basin. In December 2014 flood was greater than the flood in December 2013. This is due to the high intensity of rainfall 1477.8 mm and 94% (1385.9 mm) from the product water. In addition, a reduction in stand LULC vegetative (11.07% in 2013 to 9.11% in 2014) due to crop and replanting activities is shown by the reduction of AET (99.55 mm in 2013 and 91.96 mm in 2014). From these findings, it is recommended replanting scheme is taken into account in the design of non-structure flood mitigation.

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LIST OF SYMBOLS

SBPWM	Simple Boost Pulse Width Modulation
ZSI	Z source inverter

LIST OF ABBREVIATIONS

LULC	Land Use Land Cover
DID	Department of Irrigation and Drainage
AET	Actual Evapotranspiration
TRMM	Tropical Measuring Mission
TMPA	TRMM Multi-Satellite Precipitation Analysis
NDVI	Normalized Difference Vegetation Indices
MMS	Malaysia Meteorological Service

CHAPTER 1

INTRODUCTION

1.1 Background of Study

A flood is an unwanted overflow of water that submerges land which is usually dry. Floods could be caused by one of the following; overflow of water bodies, increases river flow rate exceeds the capacity and heavy and long-duration rainfall. Some floods develop slowly, while others such as flash floods, can develop in just a few minutes and without visible signs of rain. Additionally, floods can be local, impacting a neighborhood or community, or very large, affecting entire river basins.

The primary effects of flooding include loss of life, damage to buildings and other structures, including bridges, sewerage systems, roadways, and canals. In Malaysia, The Department of Irrigation and Drainage (DID) has estimated that about 29,000 km^2, or 9%, of the total land area and more than 4.82 million people (i.e. 22% of the population) are affected by flooding annually. The damage caused by flooding is estimated to be about US$310 million (Chan, 2005). Most flood incident related to heavy rainfall. There are three type of rainfall, orographic, convective and monsoon. Meanwhile, two major types of floods occur in Malaysia, namely flash or localized floods which is related to orographic and convective rainfall and monsoon floods which is related with monsoon season rainfall.

While monsoon floods are governed by heavy and long-duration rainfalls, more flash or localized flooding, which occurs especially in newly developed town areas, has been reported more frequently in recent years. In October 2003, major flooding affected a large area in the northwestern part of Peninsular Malaysia, including the states of Kedah, Penang and Northern Perak. The December 2007 flood, on the other hand, occurred in the state of Pahang, after more than 30 years (DID, 1974) since the last flood of a similar magnitude in 1971. Flash floods have occurred more frequently in the country since the 1980s, with this type of floods often having a drastic impact.

1.2 Problem Statement

Land use land cover (LULC) changes affected the hydrological cycle and water yield availability (Shengping Wang, 2013; Zhiqiang Zhang, 2013; Huxman and Scott, 2007). Water yield increase up to 190% after forest clearing for agricultural activity in Peninsular Malaysia (Abdul Rahim Nik, 1988). Access water-yield could be able flooding any area.

Kemaman District where Kemaman River Basin located flooded two consecutive years 2013 and 2014. Dec, 2014 was the worst floods Kemaman had ever experienced (Wan Hisham Wan Abdul Hamid, 2014). Heavy rain in the interiors of Kemaman was a cause for concern among residents in low-lying areas (New Straits Times, 2014). The study should be conducted to assess the LULC impact on flood.

1.3 Objectives of Study

The study main objective were assessing of LULC impact on flood in Kemaman River Basin. To achieve the study main objective, the specific study were performed as follows:

i. To analyse the rainfall, actual evapotranspiration (AET) and water surplus (water-yield) in Kemaman River Basin, and
ii. To analyse the LULC impact on flood in Kemaman River Basin.

1.4 Scope of Study

1) The study area at Kemaman River Basin.
2) The duration of data collection about ten years which is from October 2006 to March 2016.
3) The flooding data collected from the newspaper.

4) The rainfall data derived from satellite image data Tropical Measuring Mission (TRMM).
5) The LULC types data will be obtain from the satellite images or topographic map.

1.5 Significant Of Study

Land use won't not appear like the most exciting theme, but rather it is imperative to concentrate on. As human aspirations and population increase, land becomes very important. Land use change is perhaps the most observable of all environmental changes. Because land use change is connected to a wide range of societal and environmental processes, a robust body of land use change research helps us understand an extensive variety of interdependent systems, including economic activity, homeland security and natural resource management. The better we comprehend the way the world has been adjusted to human needs, and in what designs, the more we can anticipate future patterns. What is more, the better we can anticipate the future of land use, the more we can get ready for negative effects.

1.6 Thesis Structure

This proposal comprises of five sections. Part one shows an introduction of the proposal. It expresses the review background, problem statement, and objectives of the study, scope of the study and significance of the study. For part two, depict the review zone of the exploration and contains the literature review that related and reasonable for this postulation. Part three clarify the examination procedure that utilized for arranging research sort of information gathered and the strategy for information investigation to be utilized. For section four present the outcome that acquired from the review region and talked about from investigation. At last, section five includes the conclusion from the general part and related some suggestion for future work on research field.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Stream quality is a gauge of urban land-use pressure on a watershed. From channel flow and overland flow, mainly the water in a stream comes (Manning, 1996).Overseeing land use in a watershed is imperative to ensuring drinking-water supplies, recreational open doors, and stream biological system wellbeing. As population increases, demands on lands are also increasing. People need land for the food production, residential area and farming. Kemaman watershed situated in the flood prone region and experienced flood event practically consistently because of rainstorm season on the Peninsular Malaysia in month of November to February. In view of the state of the watershed that has high likelihood in subjected to the flood occurrence, it demonstrates that there was a need to do the research on impact of land use on flood for Kemaman watershed. The Kemaman River is a waterway in Terengganu, Malaysia. The Kemaman River basin is situated in the eastern piece of Peninsular Malaysia between longitude E 4° 13' 60" latitude N 103° 27' 0".Land use commonly grouped in two categories that are conversion and modification. Conversion refers to a change starting with one cover or utilize classification then onto the next and modification refers to change within the land use. An increasing and decreasing in population influenced the land cover changes.

2.2 Land Use Land Cover

The land cover depicts the land regarding the vegetation or another biophysical surface sort is available on the land. A typical land cover classification plan will have shifting levels of detail beginning with the general land cover and after that working its way down to more territory particular depictions. The level of detail given is subject to the determination of the symbolism used to deliver the group. Land cover data is quite compelling to ecological and environmental scientists who wish to survey the condition or changes in the characteristic scene. Land use studies to encouraging reasonable administration of the land, arrive cover and utilize data might be utilized for arranging, checking, and assessment of improvement, modern action, or recovery. Location of long haul changes in land cover may uncover a reaction to a move in nearby or provincial climatic conditions, the premise of earthbound worldwide observing.

Land use won't not appear like the most exciting theme, but rather it is imperative to concentrate on. To begin with, it enlightens us an awesome arrangement regarding the administrations settling on the choices for land use and the needs they hold. The better we comprehend the way the world has been adjusted to human needs, and in what designs, the more we can anticipate future patterns. What is more, the better we can anticipate the future of land use, the more we can get ready for negative effects. The investigation of land use land cover changes is imperative to have appropriate arranging and usage of normal assets and their management. Natural vegetation, for example, woodland cover, is normally the most amiable of land uses, with higher penetration and reduced overflow rates. In spite of land-use impacts, land is required to support human and biological system needs. Urban areas advance financial development and fulfil lodging, modern, and business needs of developing human populaces. Agricultural land is basic to give nourishment and fiber to developing populaces, and is an imperative wellspring of work in numerous nations.

2.3 Land-use Planning

As human aspirations and population increase, land becomes very important and leads to land-use planning. Land-use planning is imperative to alleviate the negative impacts of land use and to improve the effective use of assets with insignificant effect on future eras. "Land use planning makes the preconditions required to accomplish a sort of land use that is ecologically reasonable, socially just and attractive and monetarily solid. It in this manner initiates social procedures of basic leadership , accord building concerning the usage and security of private, collective or open ranges" (GTZ 1995: 7).To manage the development of land within their jurisdictions the governments use land-use planning. Besides, it presents a dream for the future, with long-run objectives and destinations for all activities that influence the local government. Land-use planning is characterized as an orderly evaluation of land and water potential, options for land use, and the financial and social conditions. The primary target of this arranging procedure is to allocate land uses to address the issues of individuals while protecting future assets. For various types of private development and public, the designation such as housing, industrial , business , agricultural , residential , conservation , public service , drainage , mineral resources and other areas. To develop a plan, three goals are used that is equity, efficiency and sustainability. The planning process must be iterative and continuous. For the equity it focuses on reducing inequalities in food security, housing and in income. Efficiency in land use is accomplished by coordinating distinctive land use with zones that will yield the best advantage in any event cost. Usually for the effective land-use planning, it involves scientific information on land resources, local communities, integrated evaluation of resource use and use appropriate technologies.

2.3.1 Land-use Planning Steps

For the first step, we will establish the goals and term of reference. It get started by arranging exertion is propelled by dialogs between the individuals who need the arrangement (arrive clients and government) and the organizers. A mutual exchange of ideas and information is one of the crucial first step that should be considered. The person that is responsible or in charge for the planning must take an action to brief about the problems of the area and what they want to achieve. The planner must explain clearly how a land-use plan all about. The most important things, they must determine the location, boundaries, size, centres of population and access. Next, contact the general population included. Prior to any choices are taken, delegates of the agriculturists and other land clients prone to be influenced by the plan should be reached and their perspectives acquired. The purposes is to provide an inside view of the real situation for the planning team and make the land users are aware to any changes in the land. The basic information of the area need to be acquired. This is a first phase of social affair data which will be obtained in more detail in later steps. It is required now to set up what the plan is expected to accomplish. The sorts of data required are laid out in basic data about the zone. Delineate the present land-use situation. Distinguish the issues that the plan is proposed to handle and the opportunities for development. The planning period also need to be set.

For the second step, organize the work. This progression changes the general planning strategy from Step 1 into a particular program of work. It says what should be done, settles on the techniques, and recognizes who will do it, determines the duties of every team member, plans personnel and exercises and distributes assets for the ensuing steps in the arranging procedure. The task in the land-use planning is very important because some of the task take a long period to be completed. For example, some surveys may take many months to be completed, so the gathering information must begin as early as possible. Supporting administrations must be sorted out, for instance, transport, work, cartography, printing. These must be planned so they are accessible when required, to make the best use of staff and also to stay away from superfluous expenses.

Initially, list the significant arranging errands and exercises. For every assignment, outline what should be done and in addition the talented staff and different assets required. Distinguish the general population and associations will's identity in charge of every undertaking and other people who will contribute. An agenda of employments and duties is a need. Everybody needs to realize what is required of them and to whom they are responsible. Indicate the time expected to finish every undertaking, which assignments should be finished before others can be begun and the due dates. Allot cash and hardware. Draw up spending plans for every action and rundown the assets that will be required. Table is the simplest format for the work plan.

A bar outline is an unmistakable method for showing the work plan. This depends on the idea of a former movement, an undertaking which must be finished before another can be begun. Such an outline attracts regard for what the key activities are, the place deferrals will back off the project as a whole.

For the next step is analyse the problems. First of all they need to compile all the data that is already collect that is data for population , employment and income , infrastructure , production and trends , present land use and land resources. The sources must reliable and up to date. In the map they need to identify the land-use system and land units. Then, identify the problems of the land use. To characterize an issue it is important to build up the current situation, judge courses in which it is unsuitable and recognize routes in which it may be improved. The methods to analyse the problems can be an interviews with land users, extension staff, agencies, field reconnaissance and local leaders.

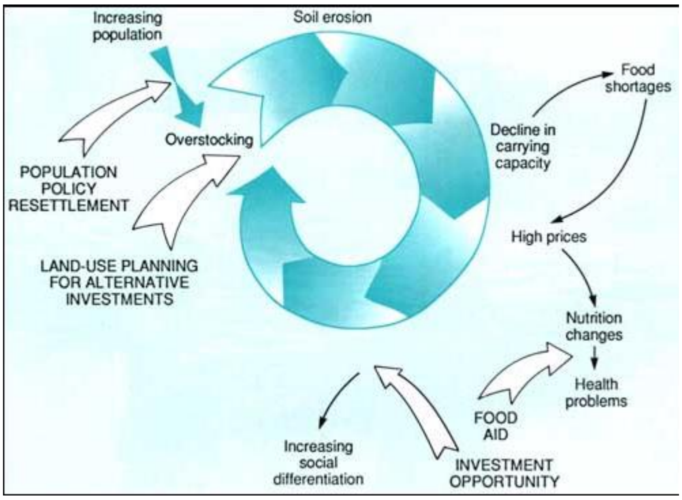


Figure 2.1 Examples Of problems (modelled)

The next step is identify opportunities for change. Since the issues requiring consideration are known, the following stride is to consider what should be possible to comprehend or enhance them. There is normally more than one approach to handle an issue. The alternatives created in this progression will rely on upon the objectives, the methodology sought after to achieve these objectives, openings and issues introduced by the general population and the land and the fund and different assets accessible. Then, next step is evaluate the land suitability. Describe land-use sorts in adequate detail for consequent investigation. Select land qualities and land attributes to be used as a part of examinations of land-use prerequisites with land. Determine their relevant land characteristics and qualities and map the land units. In sufficient detail for subsequent analysis land-use types is described.

In a specific venture, just a predetermined number of land qualities need be chosen for use in evaluation. The quality must have a considerable impact either on execution or on the expenses of generation. A few qualities influence most sorts of land use. Constraining qualities are the estimations of a land quality or land trademark that decide the class furthest reaches of land appropriateness for a specific use. The first and most essential choice is to separate land that is reasonable from that which is definitely not. Imperative criteria for choosing the reasonableness of land for a particular use are manageability and proportion of advantages to costs.

The land requirements for a few individual yields can be joined to survey the requirements of a land-use sort that incorporates a few harvests become together or in revolution. The development of a table of restricting qualities for every land reasonableness class (see figure 8) is a focal operation in land assessment. To do this, data is required on the execution of a land-use sort over a scope of locales, taken either from trials or the experience of land clients.

Compare the requirements of each land-use type with the land quantities of each land unit is the first stage in matching. The characteristics against the class limits or the land quality must be check and each land unit must be allocate based on land suitability according to the most severe limitation. Step number 6 is appraise the alternatives in environmental, economic and social analysis. The following studies allude first to individual blends of land use with land units that have been classed as appropriate in physical terms and, second, to option mixes of land use that are being considered in the plan. The studies are environmental impact assessment, social impact, economic analysis and financial analysis. Soil and water resources are examples of environmental effects that need to be considered. Danger of soil disintegration, avalanches and sedimentation, security of water supply and water quality inside and past the planning region.

The next step is choice of the best option. In these part the decision maker and the planning team play an important role. They need to make plans for conferences with the groups influenced and additionally with the actualizing organizations obtain views about possibility and agreeableness. Gather and survey the remarks got. In the light of these, roll out any vital improvements to the alternatives and choose the best option. Then, prepare the land-use plan. For the land-use plans it must contain the introduction, management problems and opportunities, direction, monitoring and revision, work plan for implementation and appendixes. In the introduction, any higher-level plans as well as local plans that are related to this plan and legislation is briefly describe including brief overview about the planning area, the location, population, current land use , production, land resources and area. The changes of the plan will bring about is summarized by geographic area or subject area is stated in the management problems and opportunities. The land-use types and standards that is applied to the whole planning area and to individual planning units is listed. After the projects is identified, the maps and diagrams is illustrated. For the monitoring and revision part, the procedure for revising the plan and reviewing progress was described. For the appendixes the supporting information such as present land use , land-use types and land requirements , land suitability , population, settlement , infrastructure , tenure , physical environment, planning units , agro climate , soil data and economic projections must be include.

The second last step is implementation of the plan. For this step, it is implementing agencies and planning team responsibility. Implementation includes an extensive variety of pragmatic activities, huge numbers of which lie past the extent of these rules. The planning team must ensure that any changes that is recommended in the plan are correctly applied and discuss any suggested modifications with implementing agencies. Maintain correspondences between all individuals and establishments taking an interest in or influenced by the plan examples from commercial organizations, non-governmental organizations, government, land users and sectoral agencies. The planning team need to help with coordination of the activities of the implementing organizations and help with organization working by fortifying connections between existing foundations, forming new bodies where important and strengthening cooperation. Arrange inquire about in association with the plan, guarantee that outcomes from research are imparted and, where suitable, consolidated into the arrangement.

Figure 2.2 Iterative Process

Last but not least , the planning team monitor and do revision.What has been achieved with what was planned is compare. Then, the elements of failure and success is identify. For any failures , the explanations is needed . Were they caused by economic or political circumstances , logistic problems of implementation , problems of participation and communication and incorrect assumptions of the plan. The goals of the plan also need to be review whether it is still valid or not.

However, for land use planning, the major challenges are to bringing together huge landowners and small farmers , in a setting of substantial economic interests in regular assets and crude materials, in strife and post-struggle territories by using land use wanting to concur on new types of concurrence. Not only that , challenges in integrating disaster risk prevention into land use planning and identifying options for alternative development through participatory.

2.4 Types of Land Use Zoning

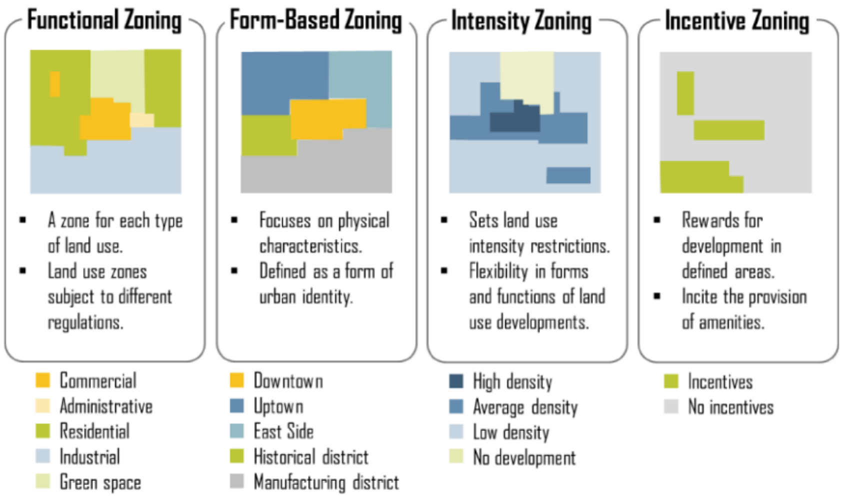


Figure 2.3 Four major types of land use zoning (Cambridge Systematics)

Zoning is identified with land use however is the means by which governments manage and control it. Zoning is your main thing when you make a specific zone, you give consent for individuals to fabricate houses, businesses or manufacturing plants, however you don't construct them yourself. Urban communities take control of this sort of thing to make their urban areas more wonderful to live in, to control contamination, secure the earth, and make productive transport links.The functional zoning is where land use zones are defined according to their function such as industrial or residential and commercial.It is the most prevalent form of zoning. Every zone sort is liable to particular principles and controls concerning the type of activities that can be constructed.Form-Based zoning is characterize zones as indicated by their physical attributes, for the most part from a urban personality viewpoint, for example, the downtown range. This type of zoning is normally less demanding to identify with the all inclusive community since it uses zonal definitions that are outstanding.

Next, intensity zoning.Characterizes land use zones by the level of allowed intensity, for example, the quantity of residential units per unit of surface or commercial surface. Such direction empowers a level of adaptability in urban improvement since it licenses designers to choose which sorts of advancement happens the length of these improvement withstand to thickness limitations.Lastly , incentive zoning. Frequently a portion of renewal or improvement arranges where developers are permitted to manufacture commercial , residential or industrial projects such as manufacturing and warehousing in particular territories through the arrangement of different incentives, for example, assess tax abatements or fundamental foundation in utilities, road and public transport services. Further, developers can be granted lower restrictions, namely density limits, if amenities are such as park areas and infrastructure, are developed as well.

2.4.1 Agricultural and Forested Areas

Agricultural areas are areas that are cultivated for crops or cleared for that purpose. Forested lands incorporate terrains used for growing timber and forests that are a piece of family farms or other real land. Agricultural land contrasts in practically every regard from the first forested land.Agricultural land use normally changes the amount and timing of streamflow,increases dregs and nutrient stacking, and may influence water chemistry and water temperatures(Dance and Hynes,1980). In the First Malaysia Plan, only 8.6 million acres of land utilised and 29.65 percent of land in Peninsular Malaysia alone was alienated for agriculture since Malaysia was an agriculture based country (Nik,1993). Agricultural and forested lands terrains ought to be overseen and monitored to save the nature of these assets. The potential corruption of water quality through uncalled for operation ought to be minimized.Agriculture and farming operations are to be directed under a program intended to minimize water contamination.

2.4.2 Residential

Residential development in the Rural Uplands is a blend of homestead homes, arbitrary parts along open streets, and little subdivisions. Permanent staying sorts incorporate both routinely constructed single-families and fabricated lodging units set up as permanent housing. New residential subdivisions built up on existing optional streets ought to give more than the base facade and extra region if important to minimize traffic hazards because of direct access of driveways to heavily traveled roads. Residential development is the predominant land-use inside the City, offering occupants a high quality and much looked for after private environment and giving a portion of the finest residential roads.

2.4.3 Commercial/Industrial

Industrial sites are best situated in territories which have offices that are intended to serve industry and where they don't bring about unfavorable effect to connecting employments. Modern destinations must have entry to great open streets, have satisfactory water supply and wastewater disposal capability. Commercial land use is the utilization of land for business purposes including building workplaces, shops, resorts and eateries instead of development of a private house. Land can likewise be utilized for developing business crops, which are harvests that are sold rather than utilized for individual utilization.

2.4.4 Recreational

Recreational land is utilized for human delight. This for the most part incorporates parks, galleries, sports grounds, and the locales of different exercises that aren't fundamental to life yet are pleasurable. Urban communities frequently particularly arrange these things to ensure their urban communities are appealing to individuals - both guests and occupants.

2.4.5 Transport

Transport land is utilized for railroads, subways , streets or air terminals that transport individuals or goods.These resemble the circulatory arrangement of the cutting edge world and important for the various land uses to work successfully.

2.5 Land Cover Class Definitions

Land cover class definitions is divided into nine.Firstly, water. In water class, it is divided by two more parts, that is called open water and perennial ice. Open water is the all areas that is cover by vegetation with less than 25% while the perennial ice is the area that is characterized by year long surface cover.Next, developed area. Develop area is the regions portrayed by a high rate (30 percent or more prominent) of developed materials. Low intensity residential is the incorporates regions with a blend of developed materials and vegetation. Built materials represent 30-80 percent of the cover. Vegetation may represent 20 to 70 percent of the cover. These ranges most normally incorporate single-family lodging units. Populace densities will be lower than in high-power local locations.High intensity residential is the incorporates profoundly created ranges where individuals live in high numbers. Vegetation represents under 20 percent of the cover. Built materials represent 80 to100 percent of the cover.

Barren is the zones portrayed by uncovered shake, rock, sand, sediment, dirt, or other earthen material, with next to zero "green" vegetation introduce paying little respect to its inborn capacity to bolster life. Vegetation, if present, is more generally separated and inadequate than that in the "green" vegetated classifications; lichen cover might be broad. Forested upland is the regions portrayed by tree cover (characteristic or semi-normal woody vegetation, for the most part, more noteworthy than 6 meters tall); tree shade represents 25-100 percent of the cover. Shrubland is the regions described by normal or semi-characteristic woody vegetation with flying stems, by and large under 6 meters tall, with people or clusters not touching to interlocking. Both evergreen and deciduous types of genuine bushes, youthful trees, and trees or bushes that are little or hindered in view of natural conditions are incorporated.

Regions overwhelmed by non-normal woody vegetation; non-regular woody vegetative overhang represents 25-100 percent of the cover it is called non-natural woody. The non-common woody arrangement is liable to the accessibility of adequate auxiliary information to separate non-characteristic woody vegetation from normal woody vegetation. Herbaceous upland is the upland territories described by normal or semi-regular herbaceous vegetation; herbaceous vegetation represents 75-100 percent of the cover. Planted or cultivated is the regions described by herbaceous vegetation that has been planted or is seriously overseen for the creation of nourishment, encourage, or fiber; or is kept up in created settings for particular purposes. Herbaceous vegetation represents 75-100 percent of the cover. Wetlands is the ranges where the dirt or substrate is occasionally immersed with or secured with water as characterized by Cowardin.

Table 2.1 Land used by District 2010

District	Agriculture	%	Building	%	Industrial	%	Forest reserve	%	Others	%	District Area
BESUT	34,825.9	28.2	5,898.6	4.8	3,302.7	2.7	56,542.0	45.8	22,798.6	18.5	123,367.8
DUNGUN	46,735.0	17.1	5,392.4	2.0	719.1	0.3	141,640.0	51.8	79,016.5	28.9	273,503.1
HULU TERENGGANU	42,971.0	11.1	4,645.1	1.2	2,075.1	0.5	221,944.0	57.3	115,827.4	29.9	387,462.6
KEMAMAN	72,938.8	28.8	7,101.0	2.8	2,963.2	1.2	76,389.0	30.1	94,167.9	37.1	253,559.9
KUALA TERENGGANU	25,447.8	42.0	8,159.5	13.5	581.4	1.0	5,420.0	9.0	20,919.5	34.6	60,528.1
MARANG	18,386.0	27.6	5,277.9	7.9	196.5	0.3	12,249.0	18.4	30,544.9	45.8	66,654.3
SETIU	38,758.6	29.7	4,459.2	3.4	90.6	0.1	43,477.0	33.3	43,650.9	33.5	130,436.3
BESUT	34,825.9	28.2	5,898.6	4.8	3,302.7	2.7	56,542.0	45.8	22,798.6	18.5	123,367.8
DUNGUN	46,735.0	17.1	5,392.4	2.0	719.1	0.3	141,640.0	51.8	79,016.5	28.9	273,503.1
HULU TERENGGANU	42,971.0	11.1	4,645.1	1.2	2,075.1	0.5	221,944.0	57.3	115,827.4	29.9	387,462.6
KEMAMAN	72,938.8	28.8	7,101.0	2.8	2,963.2	1.2	76,389.0	30.1	94,167.9	37.1	253,559.9
KUALA TERENGGANU	25,447.8	42.0	8,159.5	13.5	581.4	1.0	5,420.0	9.0	20,919.5	34.6	60,528.1

Source : Pejabat Tanah Dan Galian Negeri Terengganu(2010)

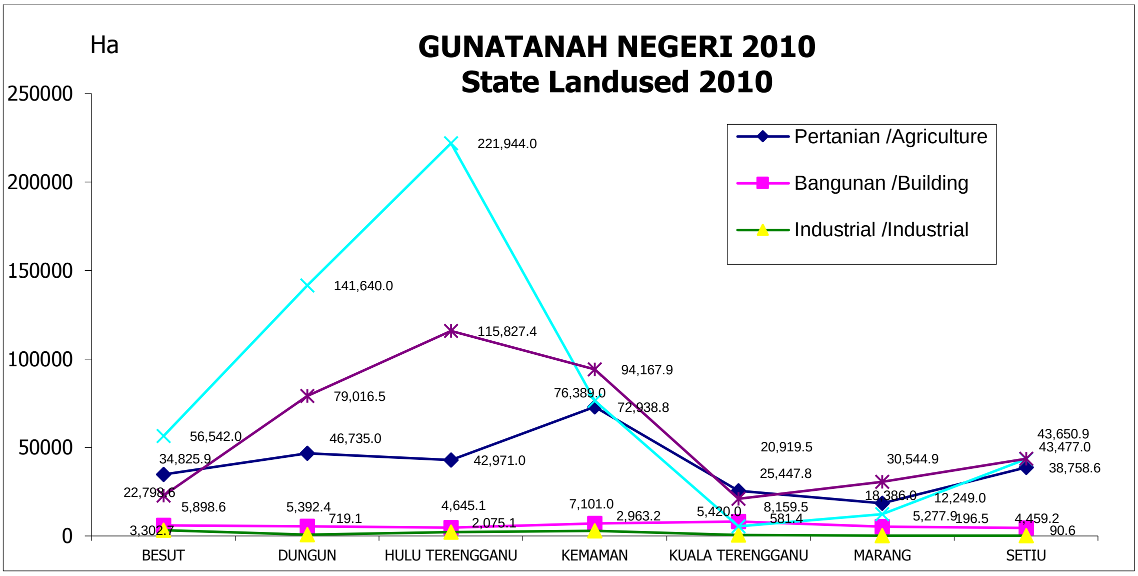


Figure 2.4 State Landused 2010 (Pejabat Tanah Dan Galian Negeri Terengganu)

2.6 Hydrological Cycle

Land use change plays an important role in modifying the hydrological cycle (Huxman and Scott, 2007), and disturbs the atmospheric concentrations of CO2, CH4 and N2O(Moiser, 1998). From the time precipitation falls on the Earth's surface until the water is come back to Earth's environment alludes to the destiny of water in and on planet Earth,it is called the hydrologic cycle. The hydrologic cycle starts with the evaporation of water from the surface of the sea. The process of hydrological cycle include precipitation, interception, evaporation, transpiration, evapotranspiration, condensation, runoff and infiltration. The essential component for transporting water from the air to the surface of the earth is precipitation.When the mists meet cool air over land, precipitation, as rain, slush or snow, is activated and water comes back to the land (or ocean). An extent of environmental precipitation evaporates. Next, interception is the procedure where precipitation is gotten and incidentally held in a vegetative shade before it achieves the land surface. Some of this precipitation might be evaporated straightforwardly or dissipated specifically or adsorbed by the plant, or it happens as throughfall or as the segment that streams down the stem to the ground.

For the evaporation, water is exchanged from the surface to the environment through evaporation, the water changes from a fluid to a gas. The sun's warmth gives vitality to dissipate water from the world's surface. Arrive, lakes, waterways and seas send up a constant flow of water vapor and plants additionally lose water to the air (transpiration).Approximately 80% of all dissipation is from the seas, with the staying 20% originating from inland water and vegetation. Follow by the transpiration. Transpiration is the procedure where water is removed from the soil by plants, leaving behind through the plant to the plant leaves and after that released to the air through the stomata. The combined process of evaporation and transpiration is called evapotranspiration. The procedure where the water goes from its vapor state to a fluid or strong express, the inverse of evaporation is called condensation.

The part of precipitation on a land territory that is released from the region enters through streams is called runoff. The part lost without entering the dirt is called surface runoff, and the bit which the dirt before achieving a stream is called groundwater runoff. As a number of groundwater increments or abatements, the water table rises or falls appropriately. At the point when the whole range beneath the ground is immersed, when all subsequent precipitation is forced to remain on the surface, the flooding occurs. Diverse surfaces hold distinctive measures of water and assimilate water at various rates. As a surface turns out to be less porous, an expanding measure of water stays at first glance, making a more prominent potential for flooding. Flooding is exceptionally regular amid winter and early spring on the grounds that solidified ground has no penetrability, making most water and meltwater progress toward becoming keep running off. Infiltration is the descending section of water through the dirt surface and into the upper soil layers.

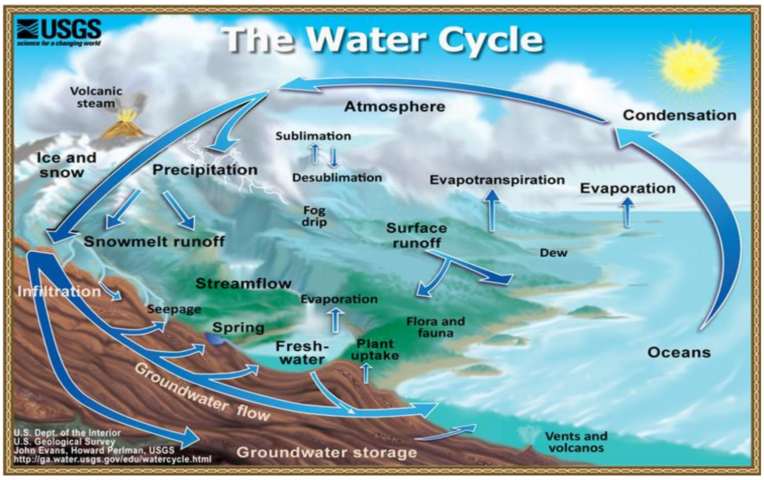


Figure 2.5 Hydrology Cycle (U.S Geological Survey)

2.7 Water Yield

Water yield is characterized as the normal measure of new water that keeps running off in an unregulated watershed.

Precipitation- Evapotranspiration = Water Yield 2.1

Some of the water is lost due to the evaporation and transpiration by plants. The water yield separated into three that is supply, service, and value.For supply, the procedure of precipitation on a scene which produces streams, and we call this as water yields. Next, for the service, the water yield can be as drinking water. Then, individuals in the scene utilize some of that water for things like drinking and water system. For the value, it goes about as hydropower creation. This outstanding water can be utilized for hydropower generation, in addition to other things.

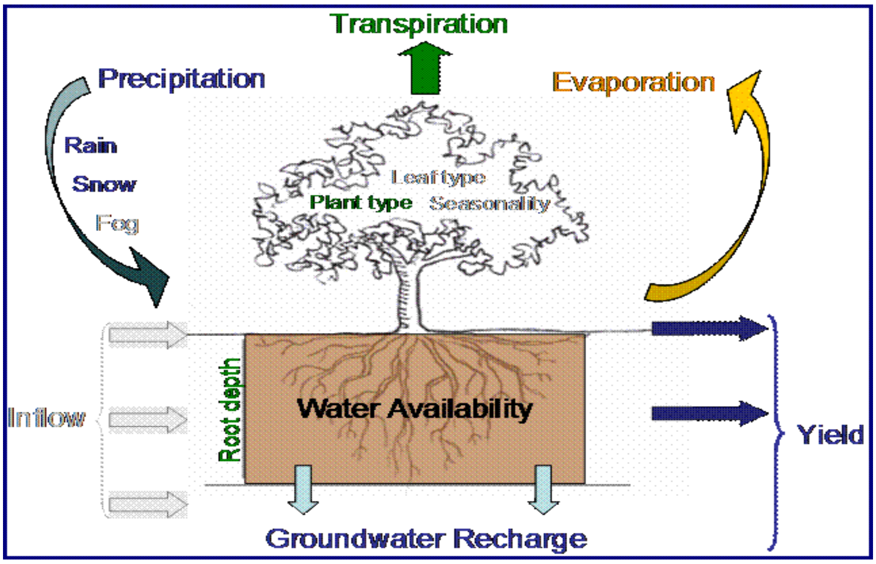


Figure 2.6 Water Yield Model

2.8 Precipitation

Precipitation is the water that tumbles from the air in either fluid or solid shape. It comes about from the buildup of dampness in the climate because of the cooling of a bundle of air. The most basic reason for cooling is progressive or adiabatic lifting of the air. Adiabatic lifting implies that a given package of air is created to ascend with resultant cooling and conceivable buildup into small cloud beads. On the off chance that these beads mix and happen to adequate size to overcome the air resistance, precipitation in some shape comes about. Precipitation happens in different structures. Rain is precipitation that is in the fluid state when it achieves the earth. Snow is solidified water in a crystalline state, while hail is solidified water in a "monstrous" state. Hail is softened snow that is an intermixture of rain and snow.Much of the precipitations that falls in Kuantan area is in liquid state, that is rain. Precipitation can be characterized by the source of the lifting movement that causes the precipitation. Every sort is described by various spatial and fleeting precipitation regimens. The three noteworthy sorts of tempests are delegated convective tempests, orographic storms, and cyclonic tempests. A fourth kind of tempest is frequently included, the typhoon or tropical violent wind, despite the fact that it is an exceptional instance of the cyclonic tempest.

2.9 Flood

Flooding is greatly hazardous and can possibly wipe away a whole city, coastline or range, and make broad harm life and property. It additionally has extraordinary erosive power and can be to a great degree damaging, regardless of the possibility that it is a foot high.Flood is a characteristic occasion or event where a real estate parcel (or zone) that is typically dry land, all of a sudden gets submerged. A few surges can happen all of a sudden and subside rapidly. Others take days or even months to manufacture and release. At the point when flood occur in a zone that individuals live, the water conveys along articles like houses, scaffolds, cars, furniture and even individuals. It can wipe away ranches, trees, and numerous all the more overwhelming things. Floods happen at unpredictable interims and fluctuate in size, length of time, and the influenced region. Note that water normally spills out of high territories to low-lying regions. This implies low-lying territories may surge rapidly before it starts to get to higher ground. Each time there are a greater number of downpours than the seepage framework can take, there can be floods. Once in a while, there is overwhelming precipitation for a brief period that outcomes in floods. In different circumstances, there might be light rain for a long time and weeks and can likewise bring about floods.

2.9.1 Types of Floods

2.9.1.1 Flash Floods

This kind happens inside a short time (2-6 hours, and once in a while inside minutes) and is ordinarily therefore of overwhelming precipitation, dam break or snow liquefy. Once in a while, extreme precipitation from moderate moving electrical storms can precipitate it. Flash floods are the most dangerous and can be deadly, as individuals are generally shocked. There is normally no notice, no planning and the effect can be extremely quick and destroying.

2.9.1.2 Rapid on Set Floods

Similar to flash floods, this sort takes marginally longer to create and the flood can keep going for a day or two as it were. It is likewise exceptionally dangerous however does not more often than not astonish individuals like Flash floods. With fast onset floods, individuals can rapidly put a couple of things right and escape before it gets terrible.

2.9.1.3 Slow on Set Floods

This kind is ordinarily accordingly of water bodies over flooding their banks. They have a tendency to grow gradually and can keep going for a considerable length of time and weeks. They typically spread over numerous kilometers and happen more in surge (fields inclined to surges in low-lying regions). The impact of this sort of floods on individuals will probably be because of ailment, ailing health or snakebites.

2.10 Remote Sensing

Remote detecting is the investigation of making estimations of the earth utilizing sensors on planes or satellites without making physical contact with it. These sensors gather information as pictures and give particular abilities to controlling, examining, and imagining those pictures. Remote detected symbolism is incorporated inside a GIS. The remote sensing is separated into two that is passive detecting and active detecting. The passive detecting is the place the data is recorded just from the daylight ricocheting off items. While the active detecting, where the satellite or flying machine really creates or turns into a flag towards the question or land. Remote sensing is utilized for mapping, review arrives utilize, and measuring. There is some an application for remote sensing such as for agriculture, water resources, environment, forests, soils, land use land cover and so on.

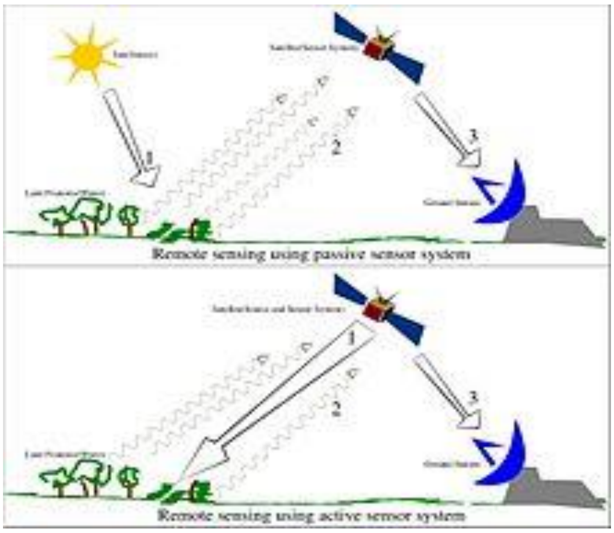


Figure 2.7 Remote Sensing (Marc Bogonovich)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This part depicts the stages required in accomplishing the review targets. There were FOUR (4) stages, to be specific; i) Data collecting, ii) Pre-processing of Data, iii) Processing and iv) Result and analysis (Fig 3.1). The initial segment will be clarifying about how every one of the information should have been gathered. The second part, pre-processing performed on the information gotten before handling information can be connected. With respect to the third part, disclosed how to distribute the Descriptive Statistical Analysis and Gumbel Distribution Function analysis. While the result and analysis are portrayed in CHAPTER 4.

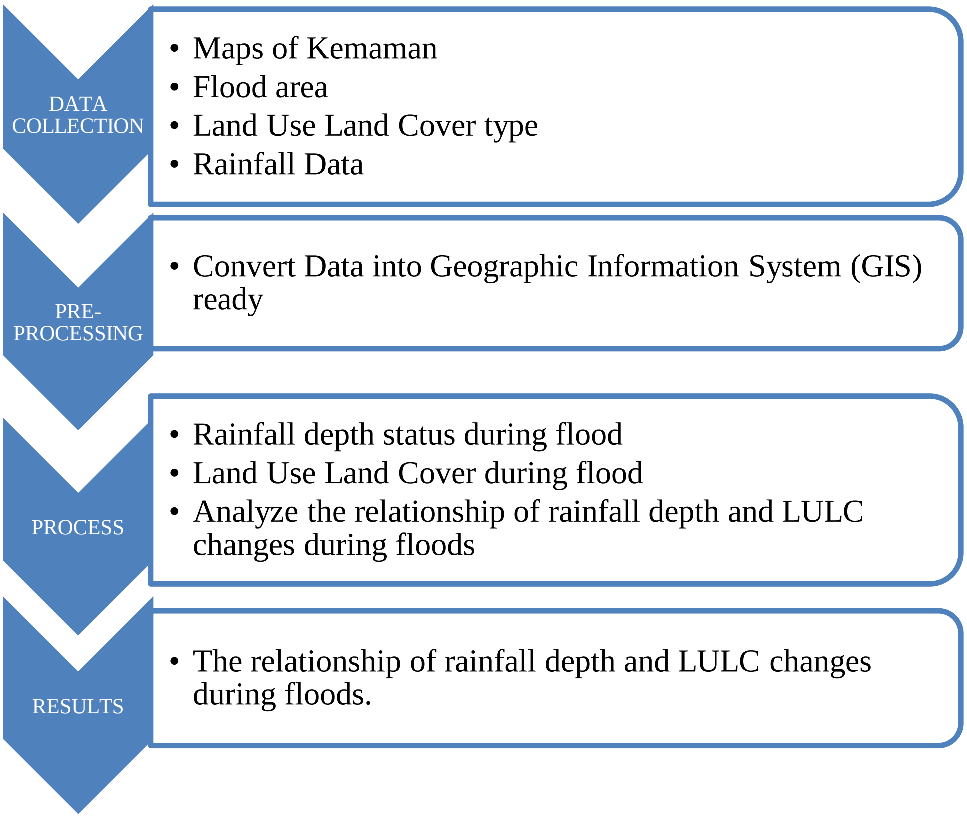


Figure 3.1 Flow chart for methodology

3.2 Data Collecting

There were three datasets used in this study, TRMM Multi-Satellite Precipitation Analysis (TMPA) satellite-based rainfall (Fig. 3), satellite-based biophysical index (i.e. Normalized Difference Vegetation Indices (NDVI), and Landsat image for year 2013 and 2014 is derived from Land Use Land Cover Status.

3.2.1 TRMM Satellite Image Data

Satellite-based TRMM rainfall data were obtained from public domain archives (NASA). The corresponding rainfall data for representative rain gauge stations within the research area were obtained from the Malaysia Meteorological Service (MMS). The AET for entire study area for October 2006 to March 2016 were derived using MODIS satellite product NDVI (normalized difference vegetation index). The data sources are obtained from the web http://neo.sci.gsfc.nasa.gov/. The AET derivation method is based on the data obtain.

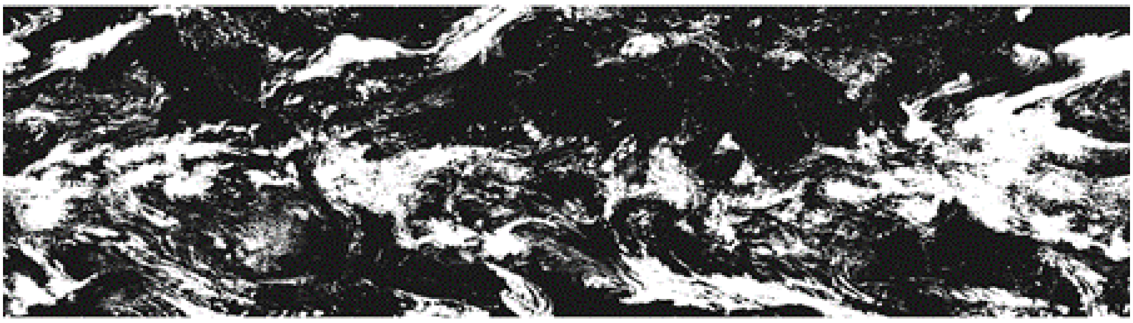


Figure 3.2 TMPA satellite-based rainfall

3.2.2 Map of Study Area

Figure 3.3 shows a map of the study area which is Kemaman, Terengganu. Kemaman is located between latitude 3°50'N–4°35'N and longitude 102°50'E–103°40’E. The total area of the Kemaman district is 8,000 square miles (254,000 hectares).

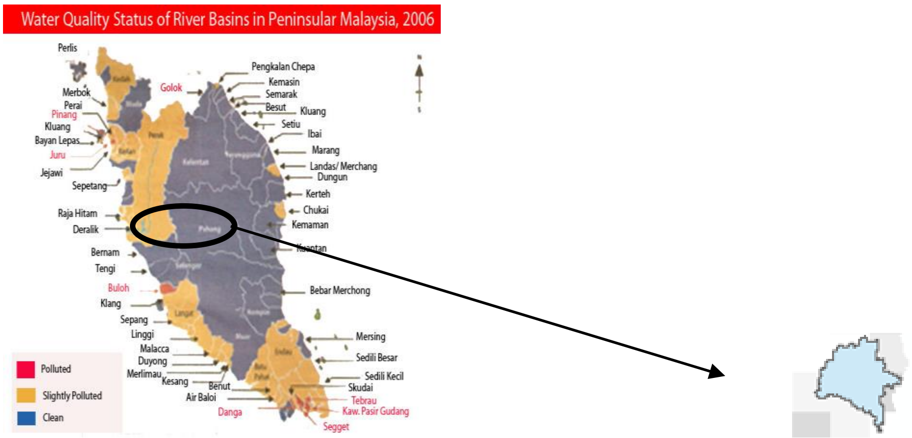


Figure 3.3 Study Area

3.3 Pre-processing

Data were converted to GIS-ready data to be used. Then, monthly TMPA satellite-based rainfall calibrated using equation produce by (M.I. Ali, 2014) to derived monthly satellite-based-calibrated rainfall and meanwhile, monthly *NDVI* images calibrated using equation produce by (M.I. Ali, 2014) to derived monthly satellite-based actual-evapotranspiration.

$$y=0.9x + c \qquad 3.1$$

(R^2=0.71, P<0.0001, n=1337), where y is calibrated TRMM data set, x=bias coefficient, and c is an offset value=7.9094

3.4 Processing

Monthly satellite-based-calibrated rainfall and satellite-based actual-evapotranspiration were overlaid to derived water-yield using water balance relationship. Mean Monthly satellite-based-calibrated rainfall, satellite-based actual-evapotranspiration and water-yield of Kemaman River Basin were derived.

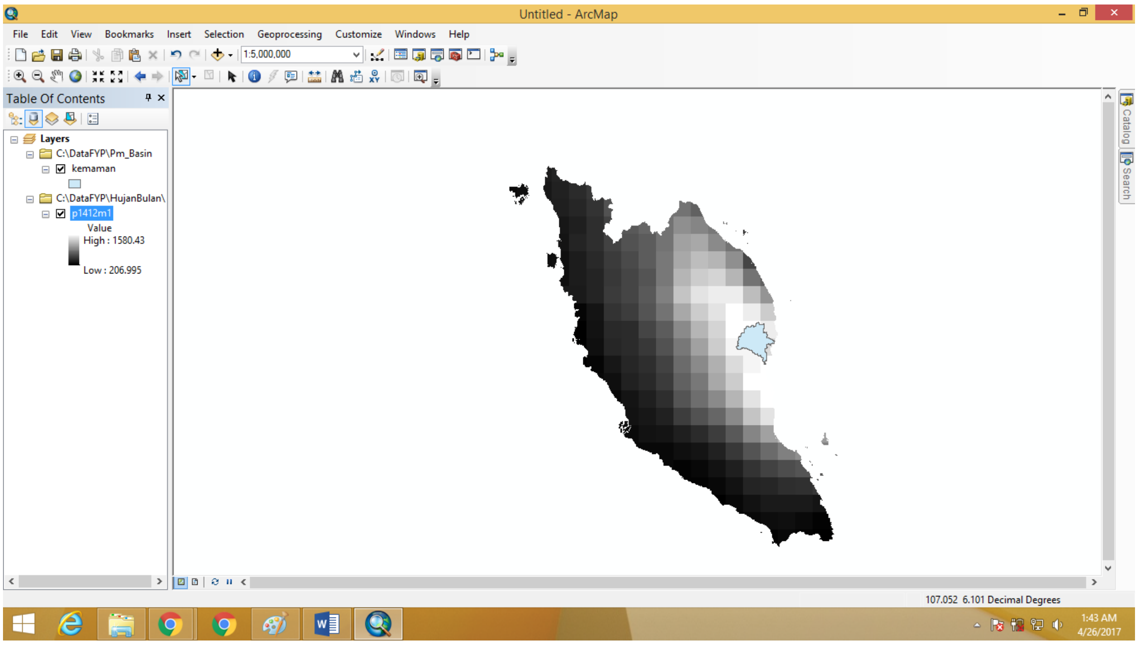


Figure 3.4 ArcGIS Satellite-based Rainfall Data in Raster Image

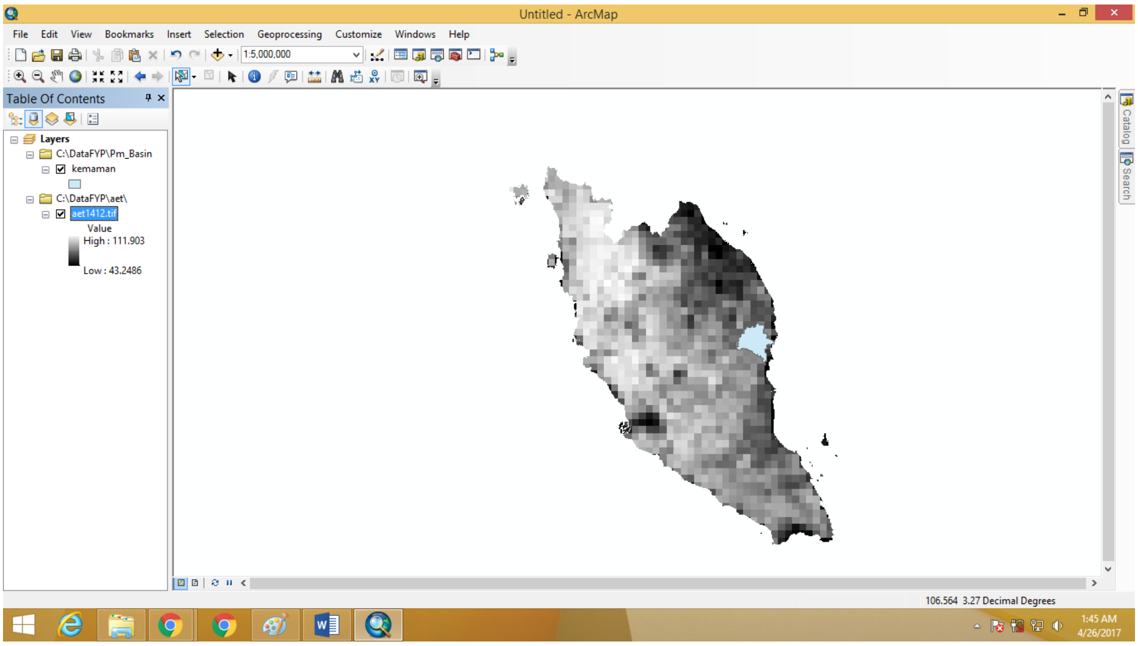


Figure 3.5 ArcGIS Satellite-based AET Data in Raster Image

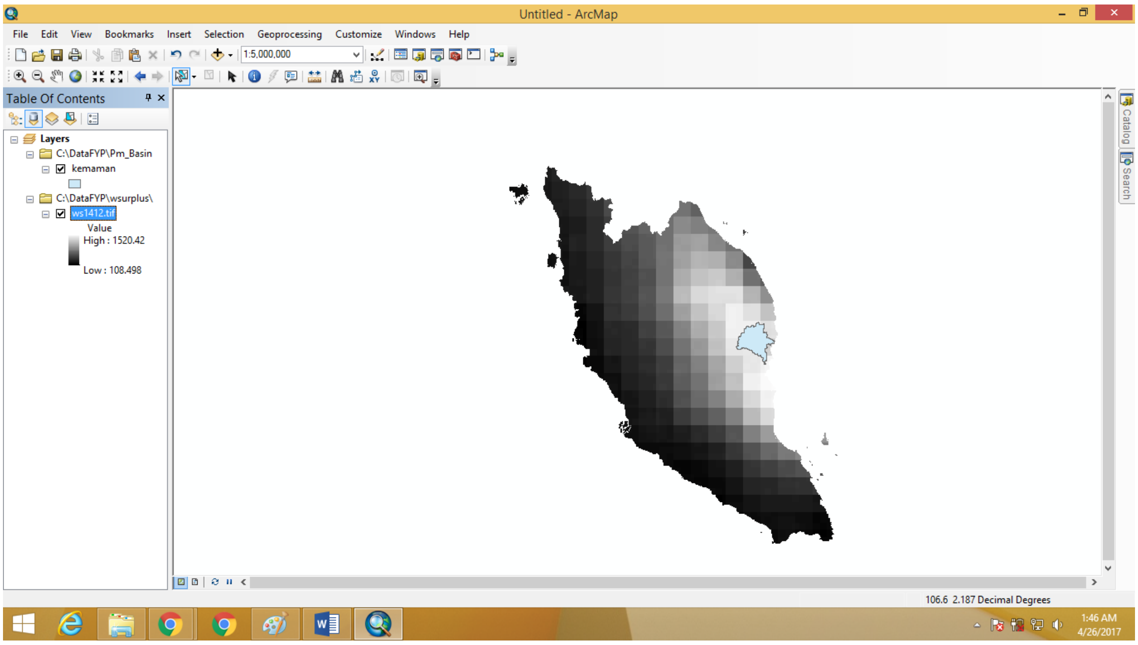


Figure 3.6 ArcGIS Satellite-based Water Surplus Data in Raster Image

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, all the data obtained is displayed in Geographic Information Systems (GIS). The results analysis is divided into six parts namely, rainfall mean, evapotranspiration, water surplus, extreme rainfall events, type of land use land cover and number of flood victims in Kemaman, Terengganu, Malaysia. The results for the temporal distribution of monthly rainfall, AET and water-yield for October 2013 to March 2015 are shown in Figure and Table below.

Table 4.1 Oct 2005- March 2006

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-05	267.7174	71.40623	105.8914	98.37251	149.0415	216.5267	169.3449
Nov-05	614.191	66.0278	107.7897	99.6496	462.8703	552.9393	514.5414
Dec-05	678.7839	62.86402	104.6259	98.9231	396.2918	685.7392	579.8607
Jan-06	166.2046	65.71143	104.3095	98.62116	48.77502	113.8598	67.58348
Feb-06	483.137	67.60969	103.044	96.55698	280.3291	443.182	386.58
Mar-06	67.38245	70.45709	111.5862	105.7604	0.00	0.00	0.00

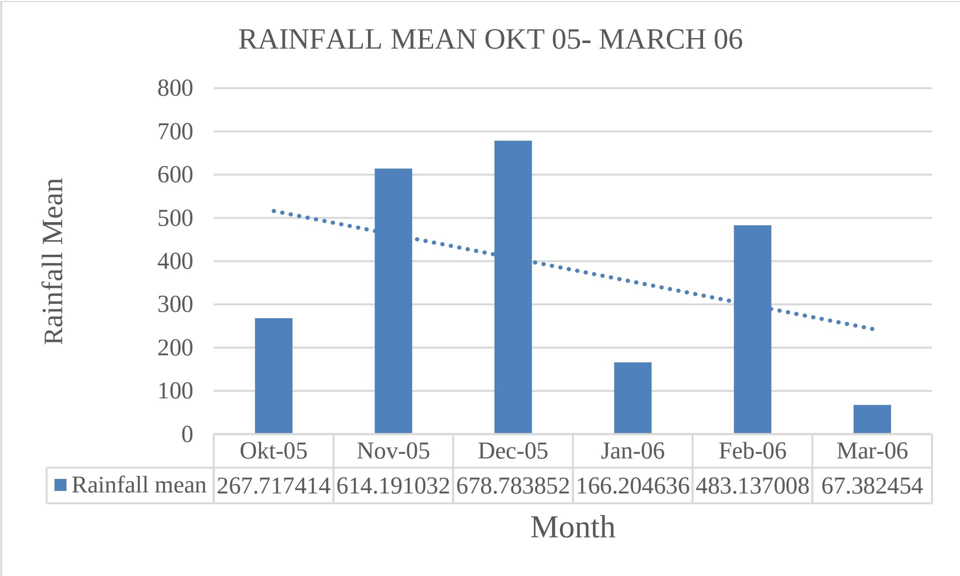


Figure 4.1 Rainfall Mean for Oct 2005 to March 2006

For October 2005 to March 2006, it can be clearly observed that the highest intensity of rainfall mean is 678.7839 mm recorded on December 2005. While the minimum average rainfall for Kemaman is in March 2006 that is 67.38245 mm (Figure 4.1).

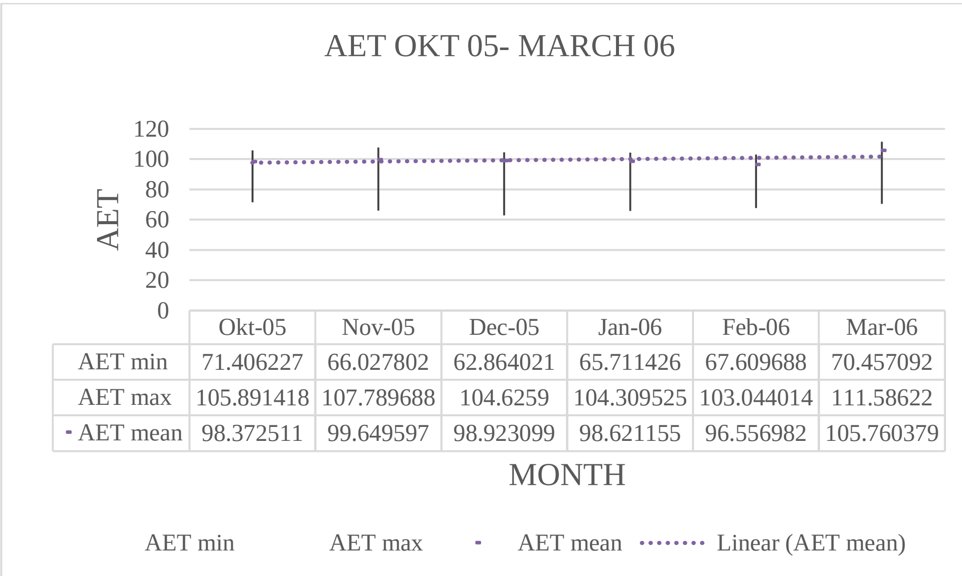


Figure 4.2 AET for Oct 2005 to March 2006

For October 2005 to March 2006, it can be clearly observed that the maximum average AET is 105.76 mm recorded in March 2006 while the minimum average AET is 96.56 mm recorded in February 2006 (Figure 4.2).

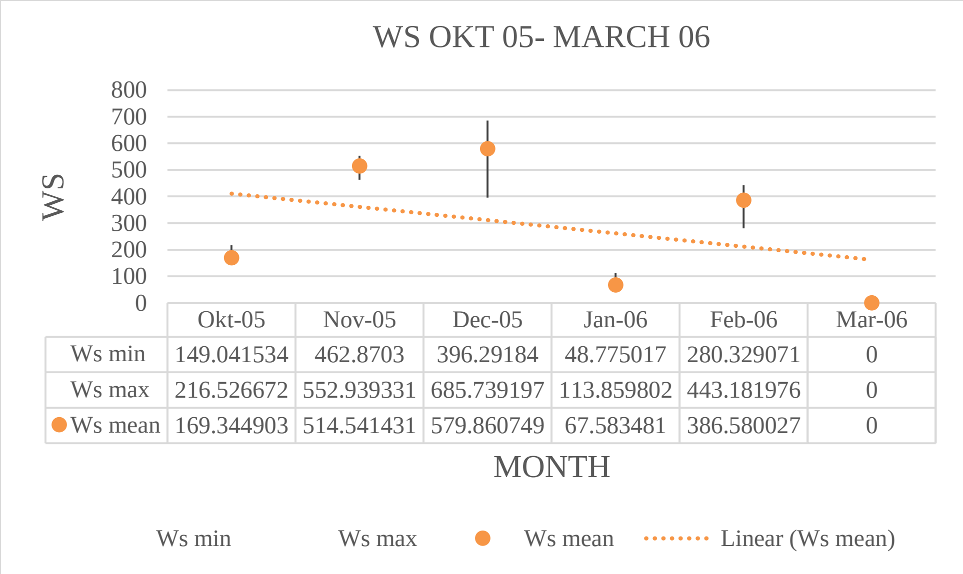


Figure 4.3 Water Surplus for Oct 2005 to March 2006

For October 2005 to March 2006, it can be clearly observed that the average maximum Surplus for Kemaman is 579.86 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2005 while for the average minimum Surplus is recorded in March 2006 (Figure 4.3).

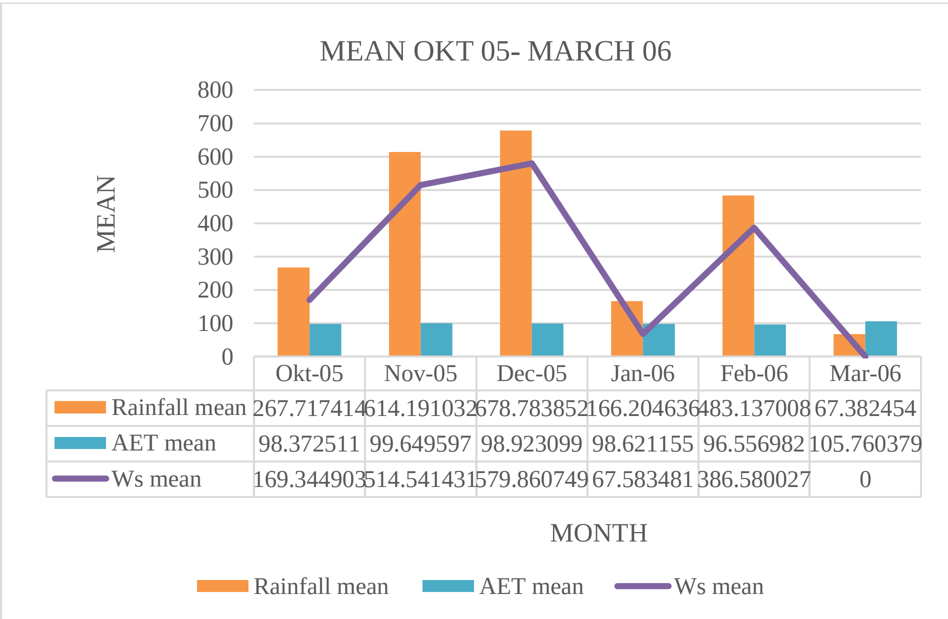


Figure 4.4 Mean for Oct 2005 to March 2006

Figure 4.4 shows that in December 2005, there is average maximum rainfall that is 678.78 mm and average maximum Surplus that is 579.86 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (March 2006).

Table 4.2 Oct 2006- March 2007

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-06	149.198	73.621	109.3716	101.1652	24.37122	79.83778	48.03318
Nov-06	310.603	66.661	103.6768	98.22861	137.1602	267.2569	212.3747
Dec-06	532.609	57.486	91.02165	80.99144	276.8773	542.0662	451.6176
Jan-07	412.078	49.576	86.59236	67.94493	249.2234	390.6989	344.1334
Feb-07	31.566	72.988	108.7388	100.8108	0.00	0.00	0.00
Mar-07	103.452	74.254	107.1569	99.80493	0.00	23.36923	3.647752

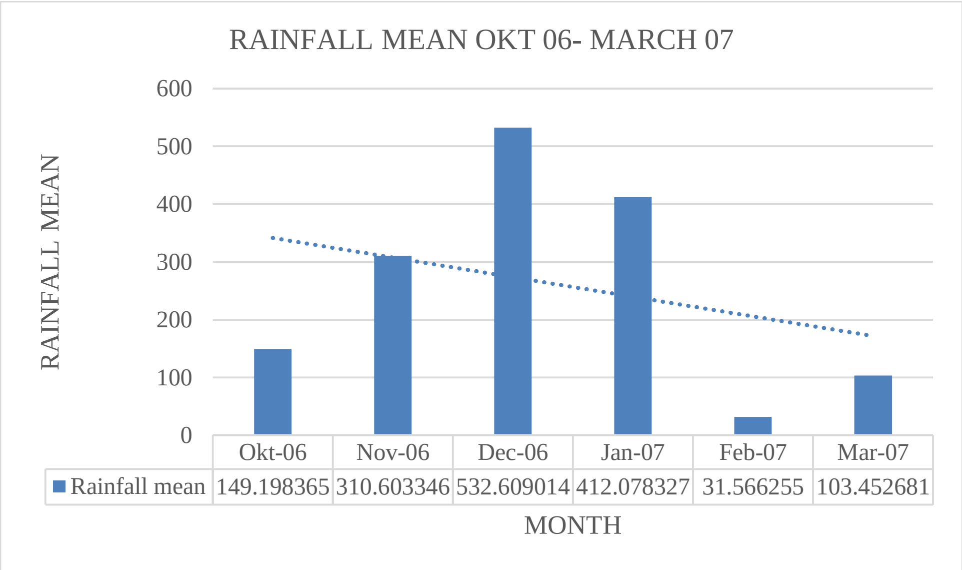
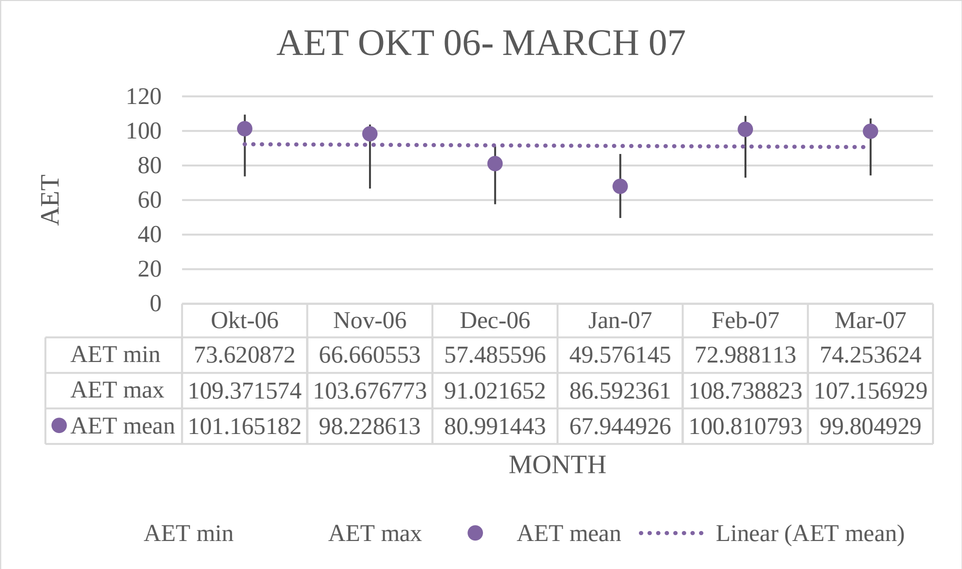


Figure 4.5 Rainfall Mean for Oct 2006 to March 2007

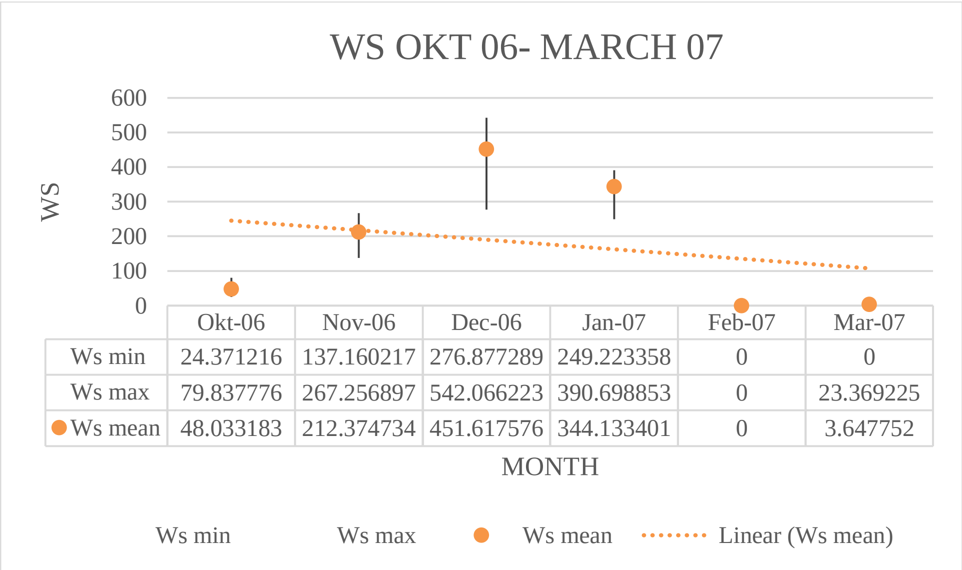
For October 2006 to March 2007, it can be clearly observed that the highest intensity of rainfall mean is 532.609014 mm recorded on December 2006. While the minimum average rainfall for Kemaman is in February 2007 that is 31.566255 mm (Figure 4.5).



	Okt-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
AET min	73.620872	66.660553	57.485596	49.576145	72.988113	74.253624
AET max	109.371574	103.676773	91.021652	86.592361	108.738823	107.156929
AET mean	101.165182	98.228613	80.991443	67.944926	100.810793	99.804929

Figure 4.6 AET for Oct 2006 to March 2007

For October 2006 to March 2007, it can be clearly observed that the maximum average AET is 101.165 mm recorded in October 2006 while the minimum average AET is 67.944 mm recorded in January 2007 (Figure 4.6).



	Okt-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
Ws min	24.371216	137.160217	276.877289	249.223358	0	0
Ws max	79.837776	267.256897	542.066223	390.698853	0	23.369225
Ws mean	48.033183	212.374734	451.617576	344.133401	0	3.647752

Figure 4.7 Water Surplus for Oct 2006 to March 2007

For October 2006 to March 2007, it can be clearly observed that the average maximum Surplus for Kemaman is 451.62 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2006 while for the average minimum Surplus is recorded in February 2006 (Figure 4.7).

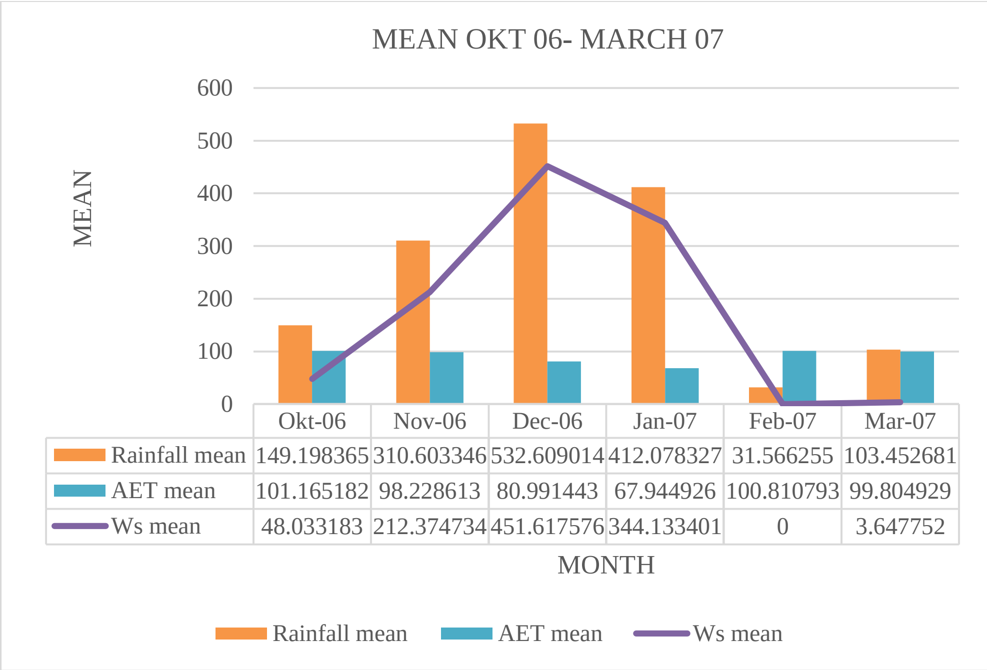


Figure 4.8 Mean for Oct 2006 to March 2007

Figure 4.8 shows that in December 2006, there is average maximum rainfall that is 532.61 mm and average maximum Surplus that is 451.62 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (February 2006).

Table 4.3 Oct 2007- March 2008

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-07	389.6355	73.3045	112.22	108.3589	235.8273	316.2141	281.2767
Nov-07	224.1782	72.98811	110.00	103.563	88.88889	141.428	120.6152
Dec-07	650.8898	62.23126	105.58	95.70416	485.8949	705.3264	555.1857
Jan-08	257.2356	66.97694	111.59	103.95	141.0749	187.956	153.2856
Feb-08	224.6271	64.12953	95.77	89.54022	91.62446	225.0689	135.0869
Mar-08	203.6827	71.08984	101.78	96.73832	73.01434	187.0111	106.9444

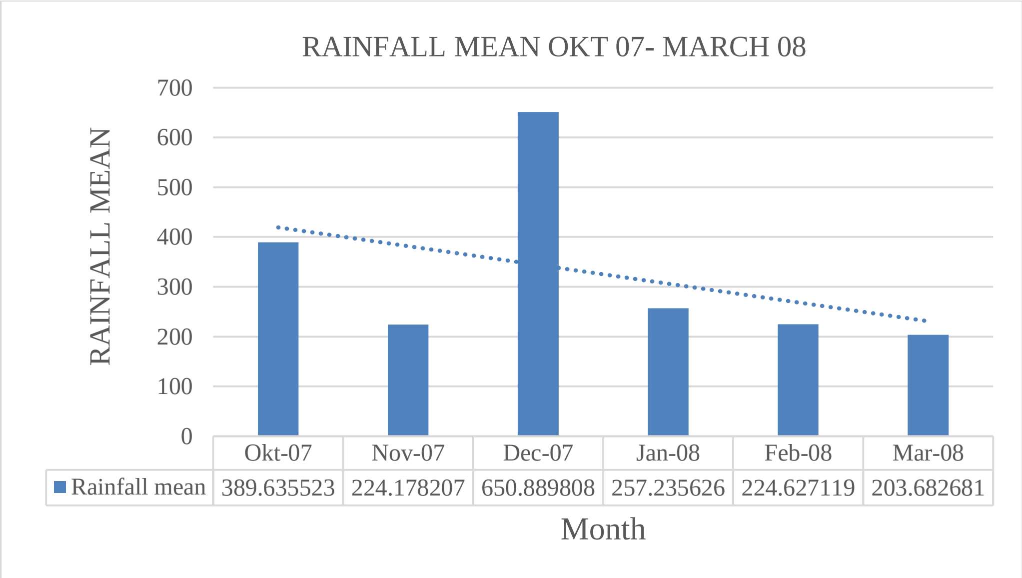


Figure 4.9 Rainfall Mean for Oct 2007 to March 2008

For October 2007 to March 2008, it can be clearly observed that the highest intensity of rainfall mean is 650.8898 mm recorded on December 2007. While the minimum average rainfall for Kemaman is in March 2008 that is 203.68 mm (Figure 4.9).

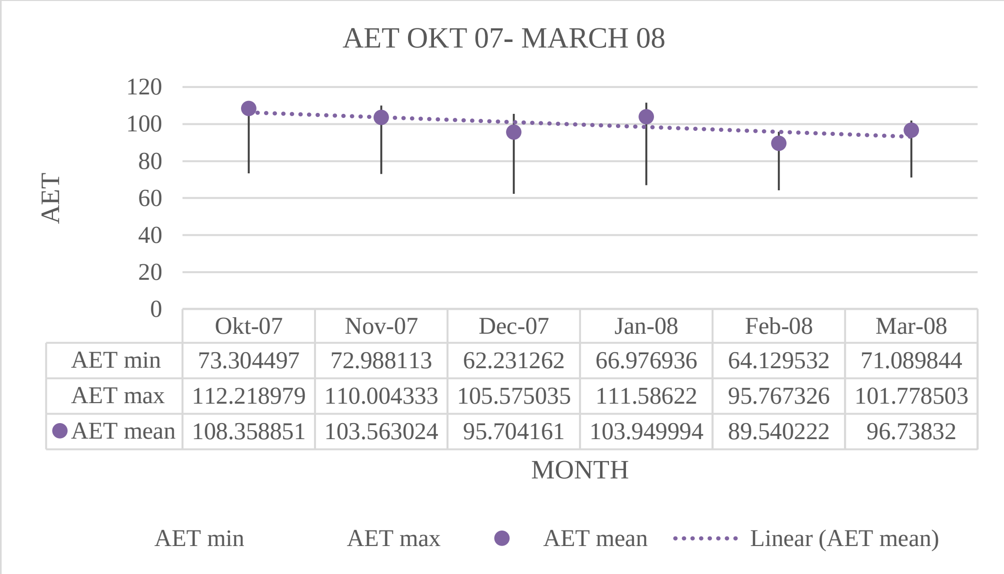


Figure 4.10 AET for Oct 2007 to March 2008

For October 2007 to March 2008, it can be clearly observed that the maximum average AET is 108.36 mm recorded in October 2007 while the minimum average AET is 89.54 mm recorded in February 2008 (Figure 4.10).

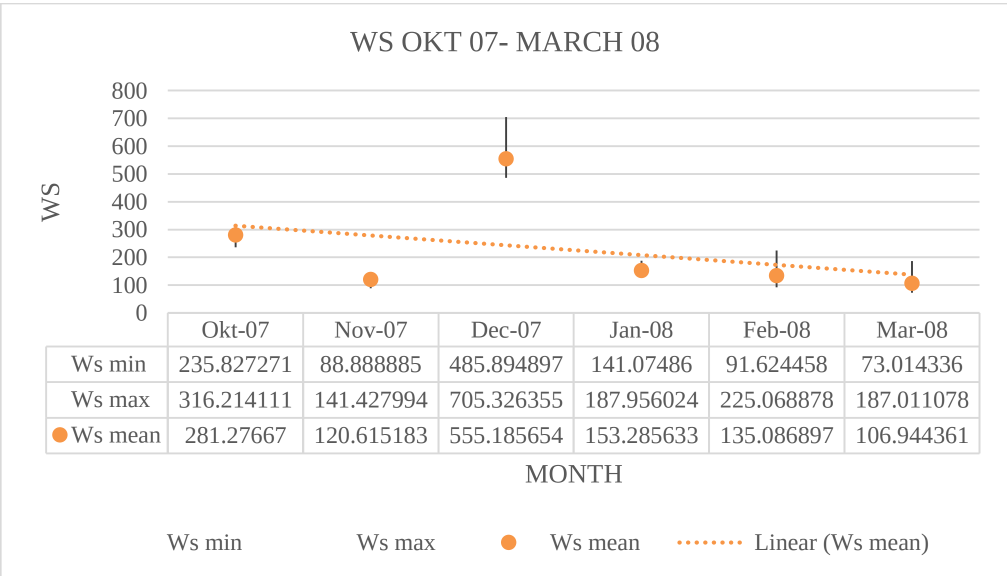


Figure 4.11 Water Surplus for Oct 2007 to March 2008

For October 2007 to March 2008, it can be clearly observed that the average maximum Surplus for Kemaman is 555.19 mm and the average minimum Surplus for Kemaman is 106.94 mm. We can see that the average maximum surplus is recorded in December 2007 while for the average minimum Surplus is recorded in March 2008 (Figure 4.11).

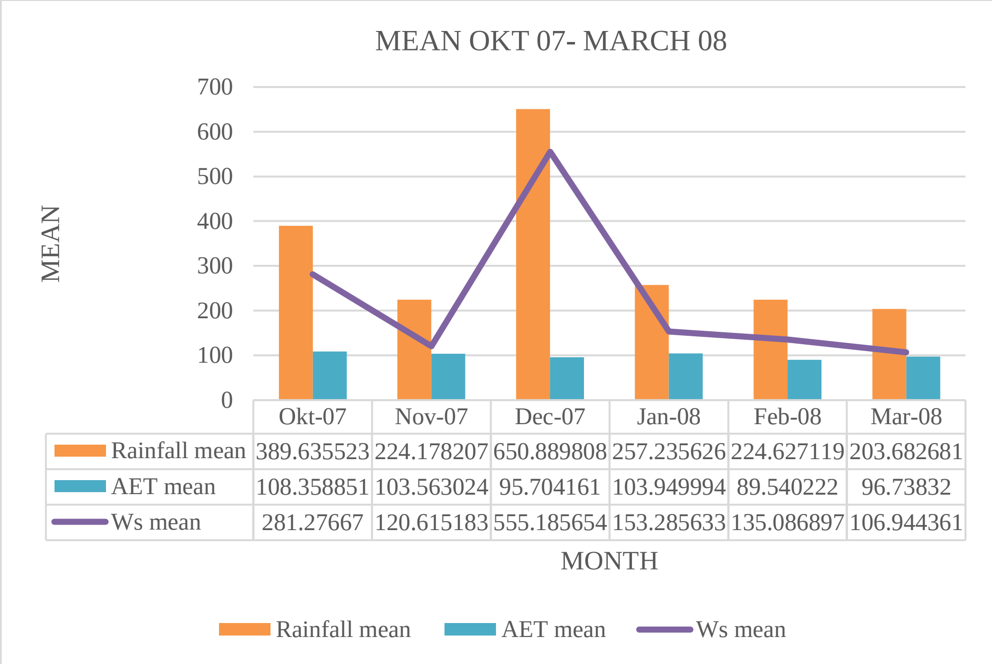


Figure 4.12 Mean for Oct 2007 to March 2008

Figure 4.12 shows that in December 2007, there is average maximum rainfall that is 650.89 mm and average maximum Surplus that is 555.19 mm while for the AET, it is recorded 89.54 mm and it is the average minimum AET (February 2008).

Table 4.4 Oct 2008- March 2009

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-08	234.5354	70.77347	110.9535	104.7337	93.63687	183.729	129.8017
Nov-08	619.9972	66.34418	105.2587	99.56714	308.3895	659.1635	520.43
Dec-08	652.2478	67.29331	102.7276	96.06841	368.7989	681.3099	556.1793
Jan-09	601.5618	64.12953	99.24748	91.33703	299.0683	424.7658	343.1975
Feb-09	42.07269	67.60969	108.7388	101.4191	0.00	0.00	0.00
Mar-09	369.3426	123.2451	123.6466	123.5926	178.4141	340.0334	245.75

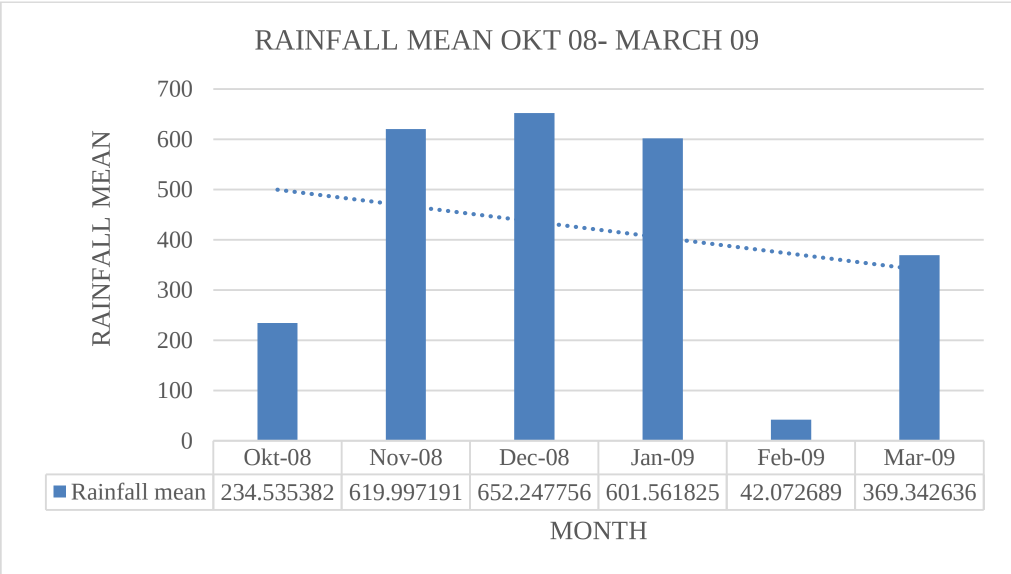
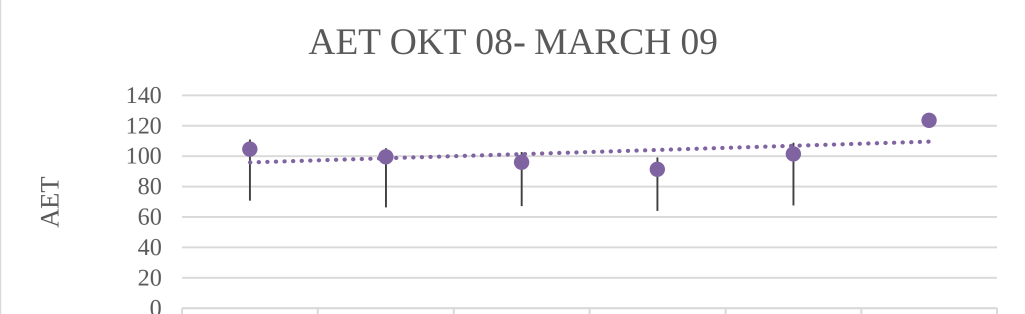


Figure 4.13 Rainfall Mean for Oct 2008 to March 2009

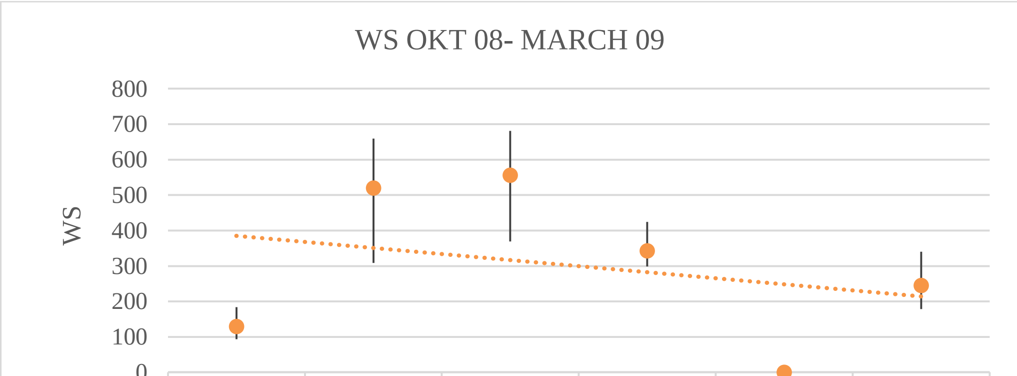
For October 2008 to March 2009, it can be clearly observed that the highest intensity of rainfall mean is 652.25 mm recorded on December 2008. While the minimum average rainfall for Kemaman is in February 2009 that is 42.07 mm (Figure 4.13).



	Okt-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09
AET min	70.773468	66.344177	67.293312	64.129532	67.609688	123.245056
AET max	110.953461	105.258659	102.727638	99.247482	108.738823	123.646629
AET mean	104.733652	99.567144	96.06841	91.337031	101.419114	123.592608

Figure 4.14 AET for Oct 2008 to March 2009

For October 2008 to March 2009, it can be clearly observed that the maximum average AET is 123.59 mm recorded in March 2009 while the minimum average AET is 91.34 mm recorded in January 2009 (Figure 4.14).



	Okt-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09
Ws min	93.636871	308.389465	368.798859	299.068268	0	178.414124
Ws max	183.728973	659.163452	681.309875	424.765839	0	340.033386
Ws mean	129.80173	520.430045	556.179343	343.197537	0	245.750021

Figure 4.15 Water Surplus for Oct 2008 to March 2009

For October 2008 to March 2009, it can be clearly observed that the average maximum Surplus for Kemaman is 556.18 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in

December 2008 while for the average minimum Surplus is recorded in February 2009 (Figure 4.15).

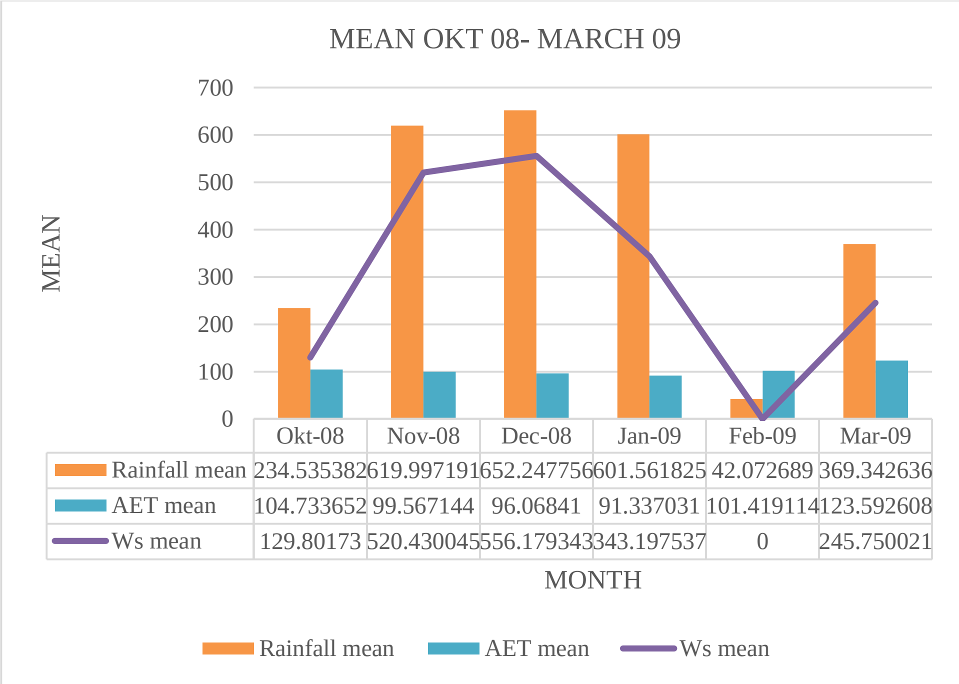


Figure 4.16 Mean for Oct 2008 to March 2009

Figure 4.16 shows that in December 2008, there is average maximum rainfall that is 652.25 mm and average maximum Surplus that is 556.20 mm while for the AET, it is recorded 91.34 mm and it is the average minimum AET (January 2009).

Table 4.5 Oct 2009- March 2010

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-09	409.8961	84.06134	112.219	107.4487	205.1935	455.91	302.4474
Nov-09	601.5618	72.35535	105.2587	97.56813	322.8581	653.785	503.9937
Dec-09	589.271	62.54764	107.1569	95.5554	455.2772	610.7139	493.7156
Jan-10	108.7011	73.62087	111.2698	101.1479	0.00	32.59704	7.553239
Feb-10	0.00	67.92606	110.6371	103.2645	0.00	0.00	0.00
Mar-10	88.97137	72.35536	107.1569	100.7448	0.00	44.55837	0.00

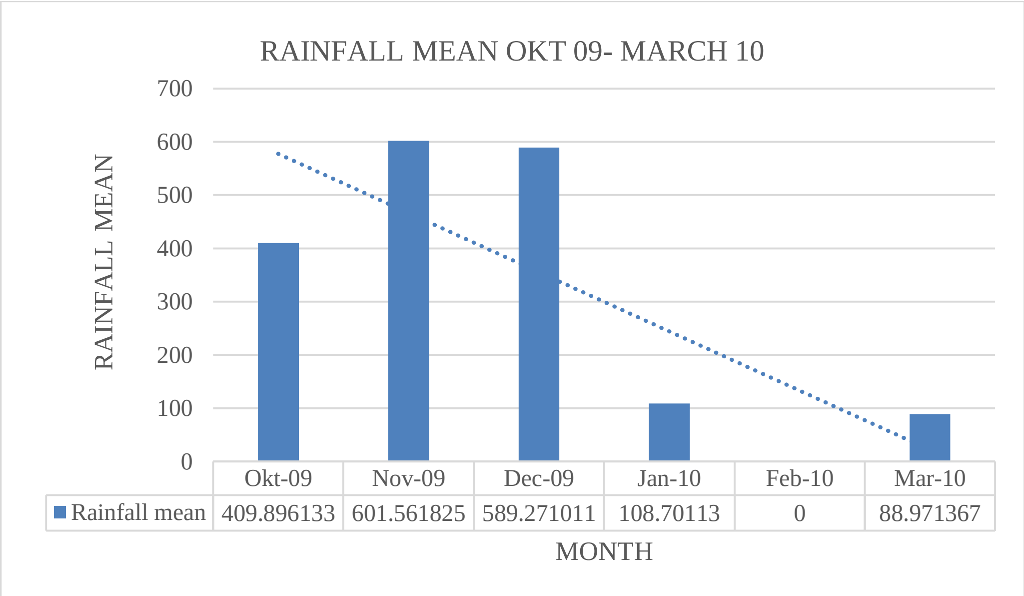


Figure 4.17 Rainfall Mean for Oct 2009 to March 2010

For October 2009 to March 2010, it can be clearly observed that the highest intensity of rainfall mean is 601.56 mm recorded on November 2009. While the minimum average rainfall for Kemaman is in February 2010 that is 0.00 mm (Figure 4.17).

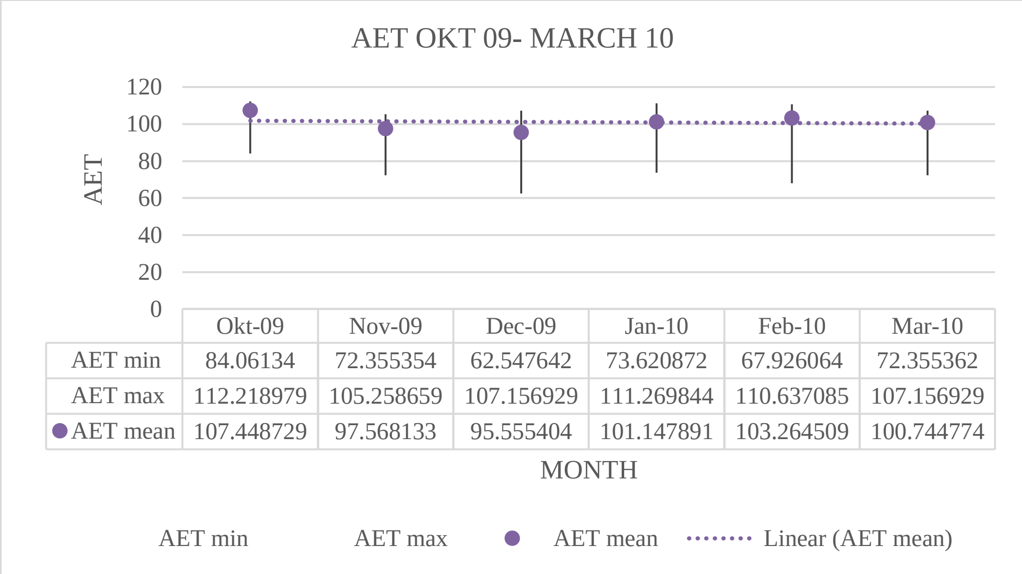


Figure 4.18 AET for Oct 2009 to March 2010

For October 2009 to March 2010, it can be clearly observed that the maximum average AET is 107.45 mm recorded in October 2009 while the minimum average AET is 95.56 mm recorded in December 2009 (Figure 4.18).

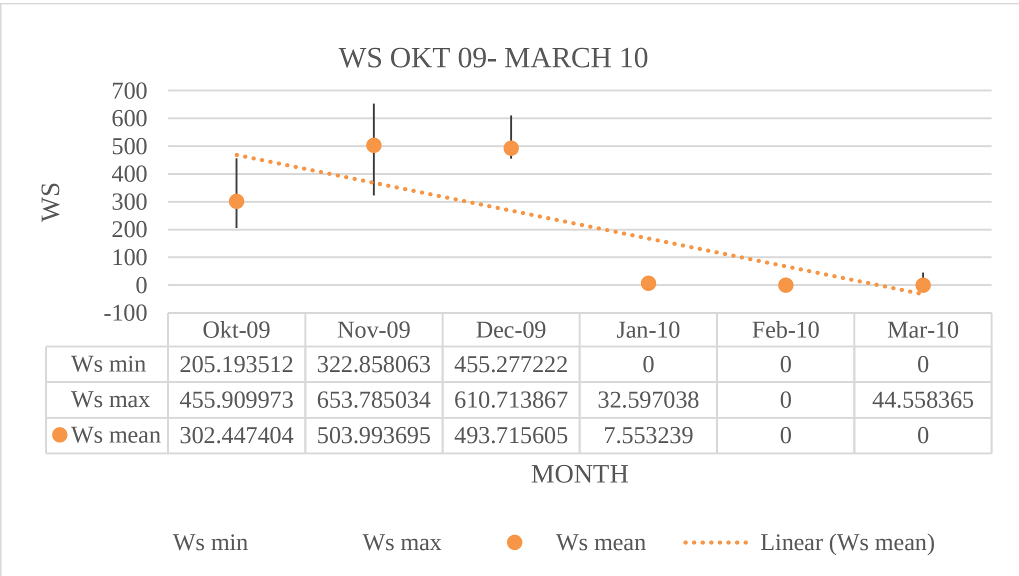


Figure 4.19 Water Surplus for Oct 2009 to March 2010

For October 2009 to March 2010, it can be clearly observed that the average maximum Surplus for Kemaman is 503.99 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in November 2009 while for the average minimum Surplus is recorded in February and March 2010 (Figure 4.19).

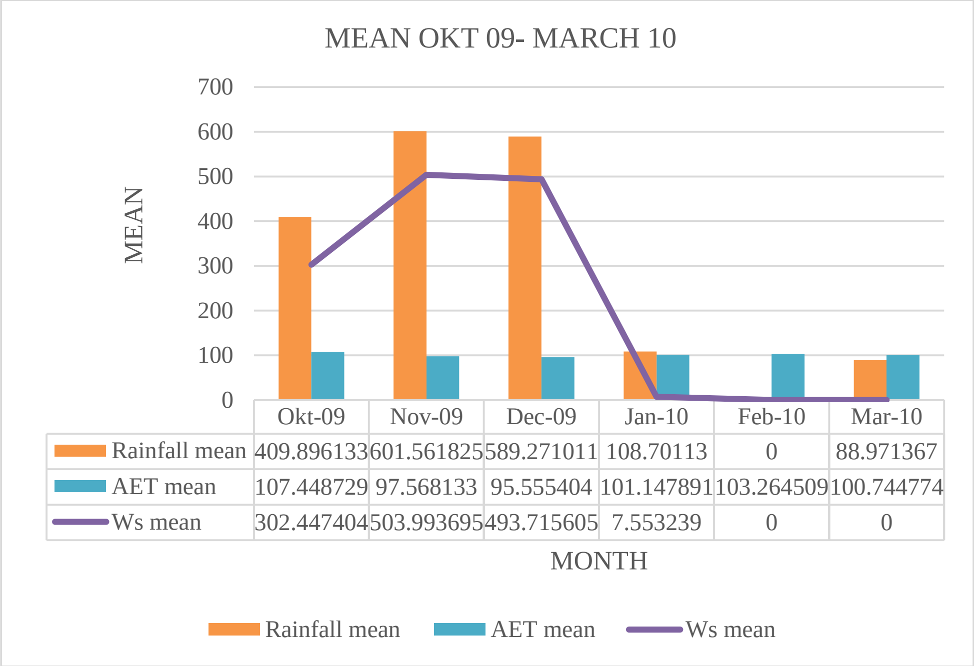


Figure 4.20 Mean for Oct 2009 to March 2010

Figure 4.20 shows that in November 2009, there is average maximum rainfall that is 601.56 mm and average maximum Surplus that is 503.99 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (February 2010).

Table 4.6 Oct 2010- March 2011

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-10	265.4957	80.2648	109.0552	104.3265	45.29486	198.3682	161.1692
Nov-10	298.6501	73.3045	106.2078	97.68874	183.0962	249.6667	200.9614
Dec-10	630.8642	61.91489	106.5242	95.90808	428.8745	636.2124	534.9561
Jan-11	374.1167	66.66055	106.5242	99.73005	217.7126	342.7899	274.3867
Feb-11	0.00	71.08984	110.9535	104.6745	0.00	0.00	0.00
Mar-11	359.0498	66.0278	99.88023	91.81117	241.9467	309.1924	267.2386

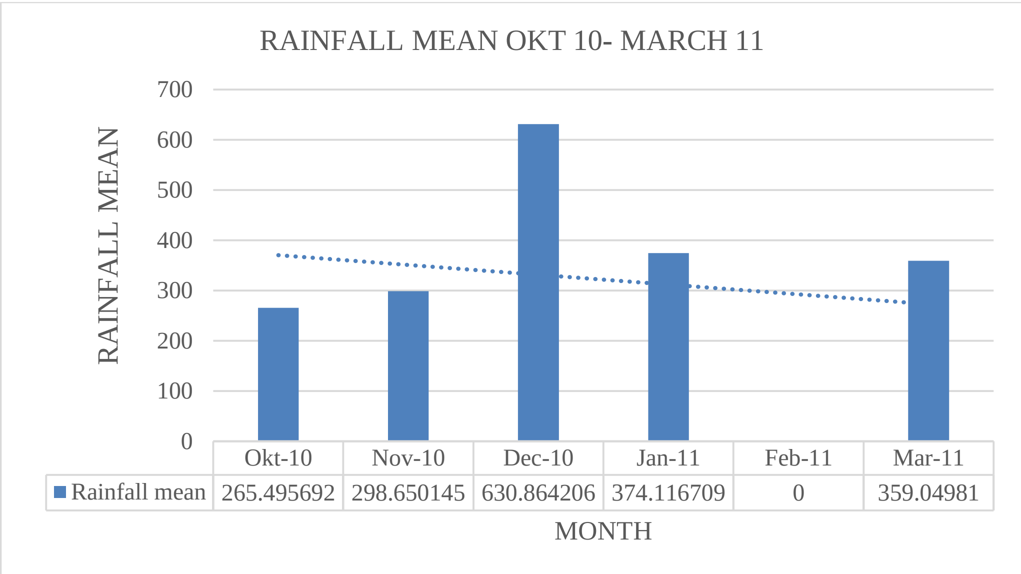
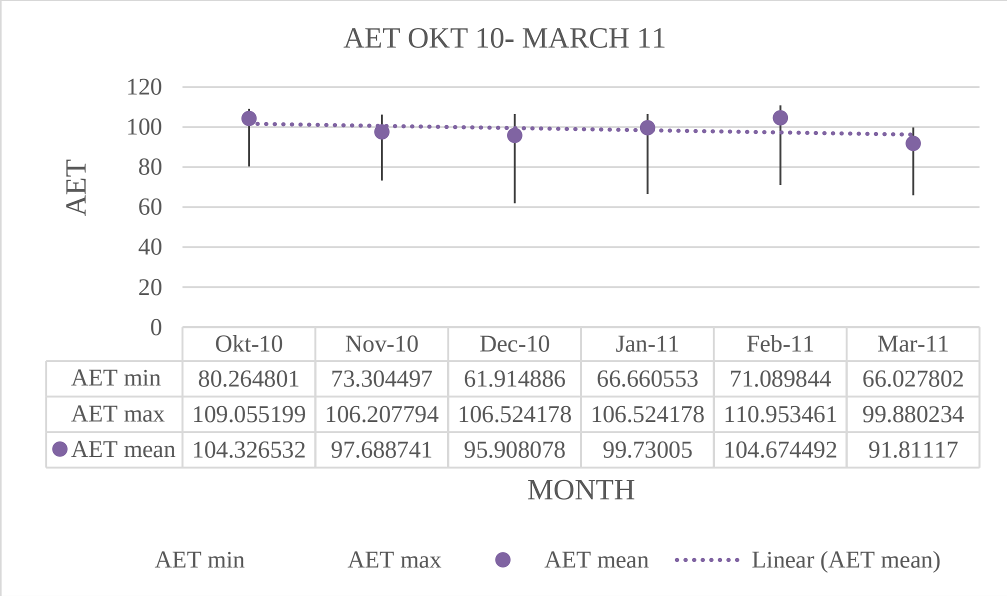


Figure 4.21 Rainfall Mean for Oct 2010 to March 2011

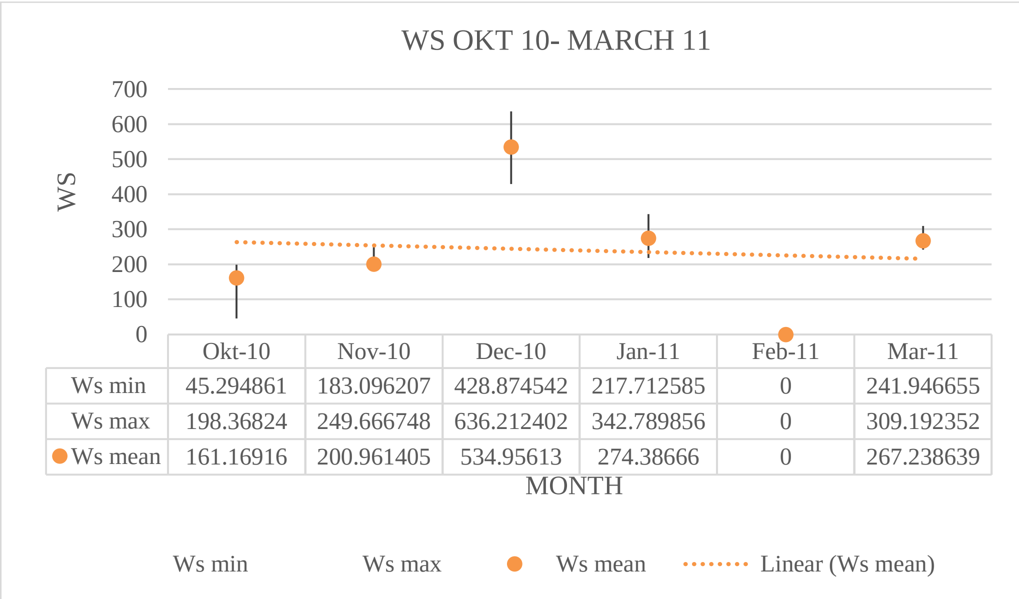
For October 2010 to March 2011, it can be clearly observed that the highest intensity of rainfall mean is 630.86 mm recorded on December 2010. While the minimum average rainfall for Kemaman is in February 2011 that is 0.00 mm (Figure 4.21).



	Okt-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11
AET min	80.264801	73.304497	61.914886	66.660553	71.089844	66.027802
AET max	109.055199	106.207794	106.524178	106.524178	110.953461	99.880234
AET mean	104.326532	97.688741	95.908078	99.73005	104.674492	91.81117

Figure 4.22 AET for Oct 2010 to March 2011

For October 2010 to March 2011, it can be clearly observed that the maximum average AET is 104.67 mm recorded in February 2011 while the minimum average AET is 91.81 mm recorded in March 2011 (Figure 4.22).



	Okt-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11
Ws min	45.294861	183.096207	428.874542	217.712585	0	241.946655
Ws max	198.36824	249.666748	636.212402	342.789856	0	309.192352
Ws mean	161.16916	200.961405	534.95613	274.38666	0	267.238639

Figure 4.23 Water Surplus for Oct 2010 to March 2011

For October 2010 to March 2011, it can be clearly observed that the average maximum Surplus for Kemaman is 534.956 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2010 while for the average minimum Surplus is recorded in February 2011 (Figure 4.23).

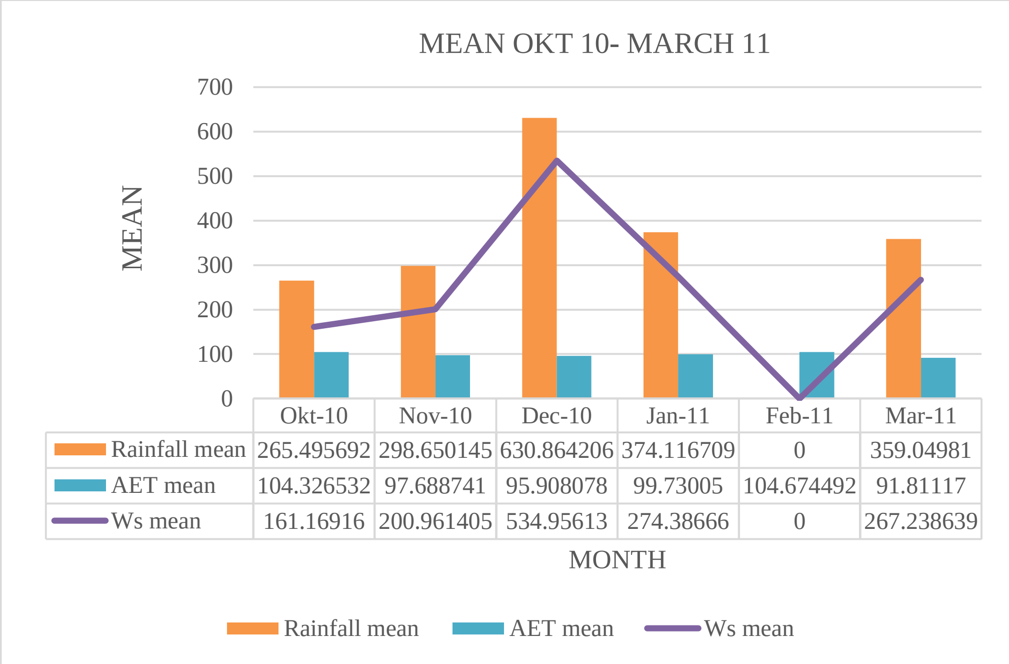


Figure 4.24 Mean for Oct 2010 to March 2011

Figure 4.24 shows that in December 2010, there is average maximum rainfall that is 630.864 mm and average maximum Surplus that is 534.96 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (February 2011).

Table 4.7 Oct 2011- March 2012

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-11	440.4542	73.30449	100.8294	89.00896	269.5611	420.0864	351.5044
Nov-11	523.6151	72.98811	106.5242	96.12375	218.6617	491.9061	427.5651
Dec-11	535.8754	57.4856	82.79582	71.6179	365.5819	641.1613	464.3427
Jan-12	285.5221	67.60969	103.6768	93.39034	164.8646	244.7408	192.0979
Feb-12	50.38188	68.24245	110.0043	99.41096	0.00	0.00	0.00
Mar-12	248.1172	70.45709	104.9423	100.6492	73.01434	197.544	147.4451

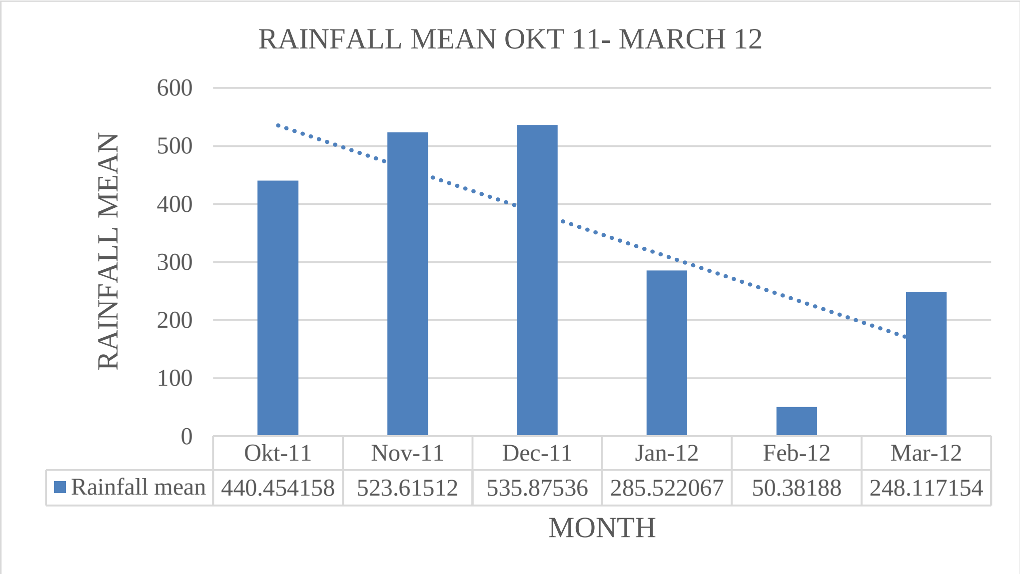
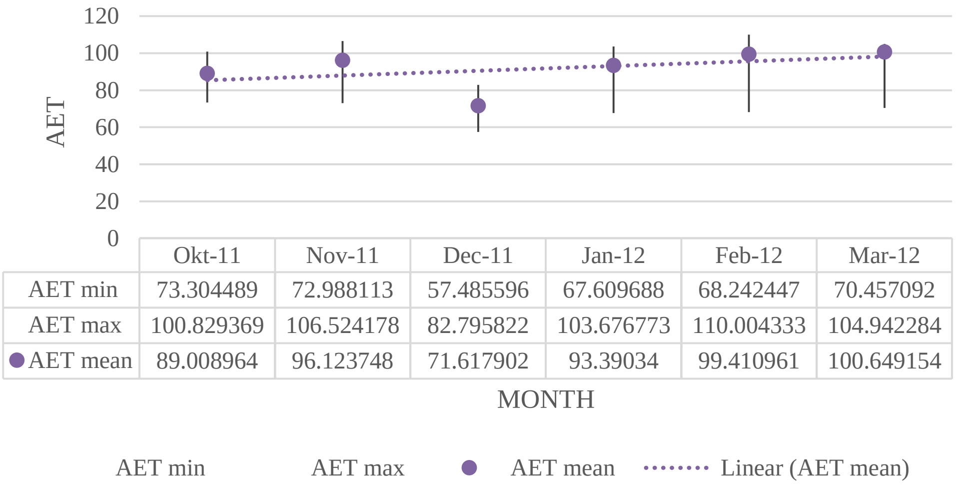


Figure 4.25 Rainfall Mean for Oct 2011 to March 2012

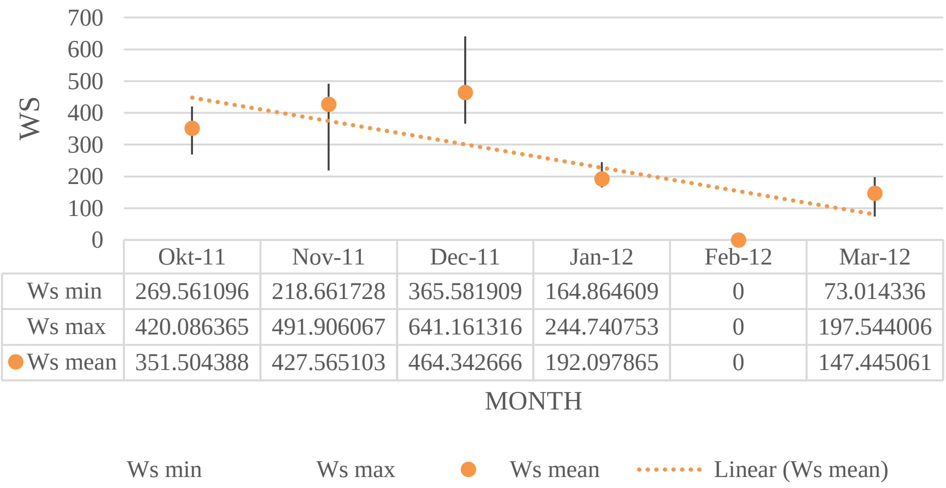
For October 2011 to March 2012, it can be clearly observed that the highest intensity of rainfall mean is 535.88 mm recorded on December 2011. While the minimum average rainfall for Kemaman is in February 2012 that is 50.38 mm (Figure 4.25).



	Okt-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
AET min	73.304489	72.988113	57.485596	67.609688	68.242447	70.457092
AET max	100.829369	106.524178	82.795822	103.676773	110.004333	104.942284
AET mean	89.008964	96.123748	71.617902	93.39034	99.410961	100.649154

Figure 4.26 AET for Oct 2011 to March 2012

For October 2011 to March 2012, it can be clearly observed that the maximum average AET is 100.65 mm recorded in March 2012 while the minimum average AET is 71.62 mm recorded in December 2011 (Figure 4.26).



	Okt-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
Ws min	269.561096	218.661728	365.581909	164.864609	0	73.014336
Ws max	420.086365	491.906067	641.161316	244.740753	0	197.544006
Ws mean	351.504388	427.565103	464.342666	192.097865	0	147.445061

Figure 4.27 Water Surplus for Oct 2011 to March 2012

For October 2011 to March 2012, it can be clearly observed that the average maximum Surplus for Kemaman is 464.34 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2011 while for the average minimum Surplus is recorded in February 2012 (Figure 4.27).

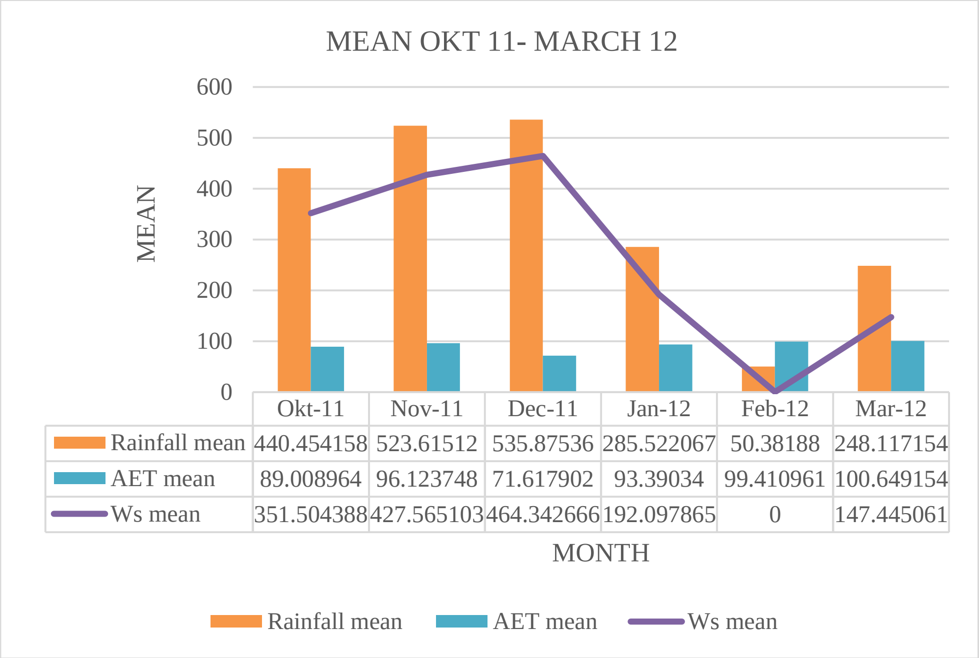


Figure 4.28 Mean for Oct 2011 to March 2012

Figure 4.28 shows that in December 2011, there is average maximum rainfall that is 535.88 mm and average maximum Surplus that is 464.34 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (February 2012).

Table 4.8 Oct 2012- March 2013

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-12	234.5404	78.68292	113.8009	102.702	101.8808	198.3682	131.8384
Nov-12	165.4222	68.87521	102.4113	94.43859	58.64045	98.16445	70.98362
Dec-12	790.2296	61.91489	88.80701	84.07393	510.7448	766.8559	706.1557
Jan-13	158.9938	65.07867	106.2078	97.35951	32.61931	126.8746	61.63424
Feb-13	366.2158	66.0278	102.0949	93.11258	199.9501	333.6997	273.1032
Mar-13	0.00	69.19158	110.0043	103.0084	0.00	0.00	0.00

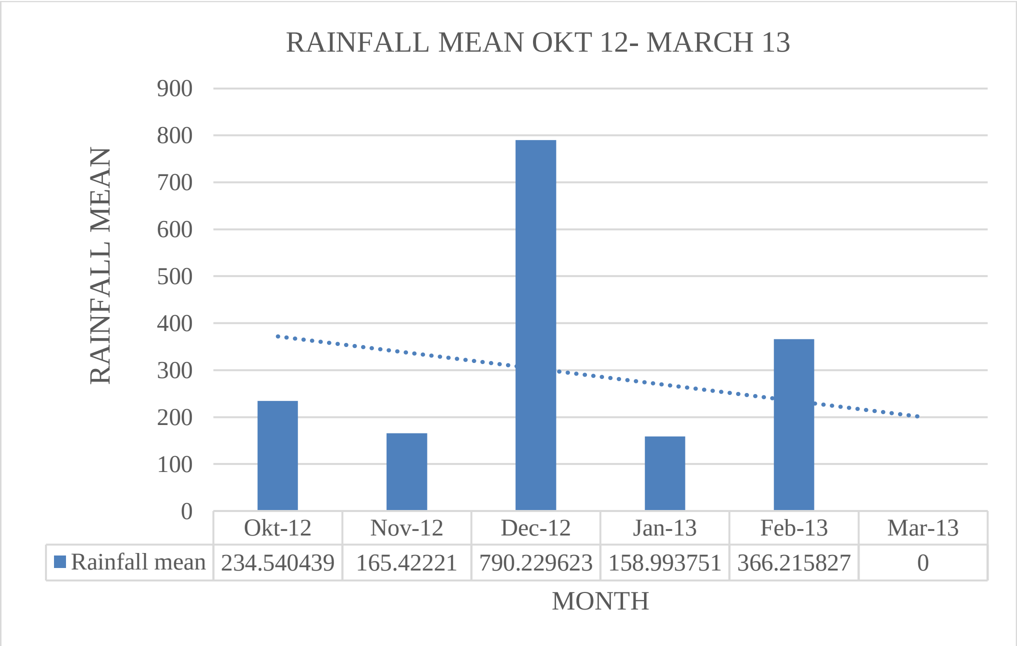
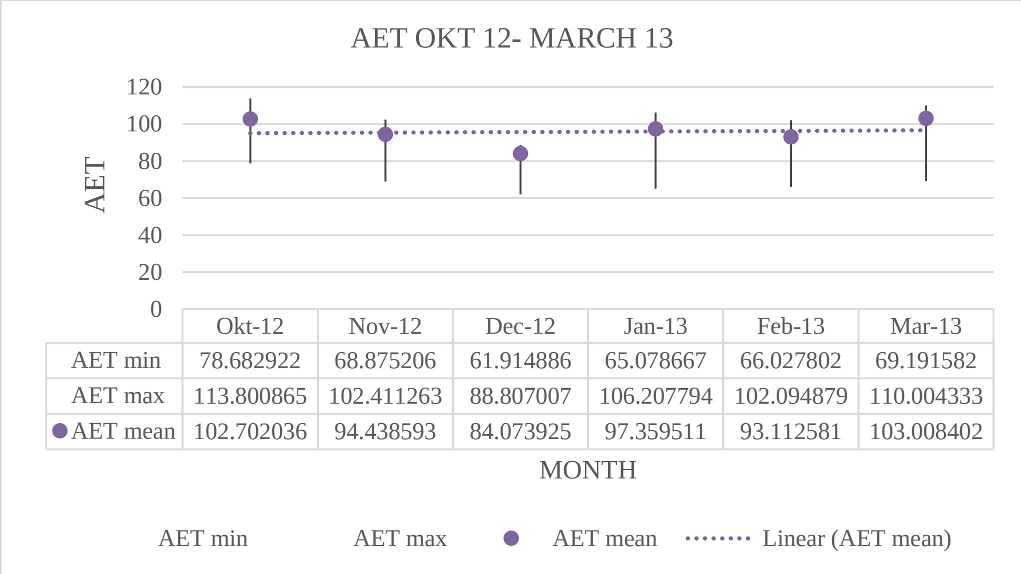


Figure 4.29 Rainfall Mean for Oct 2012 to March 2013

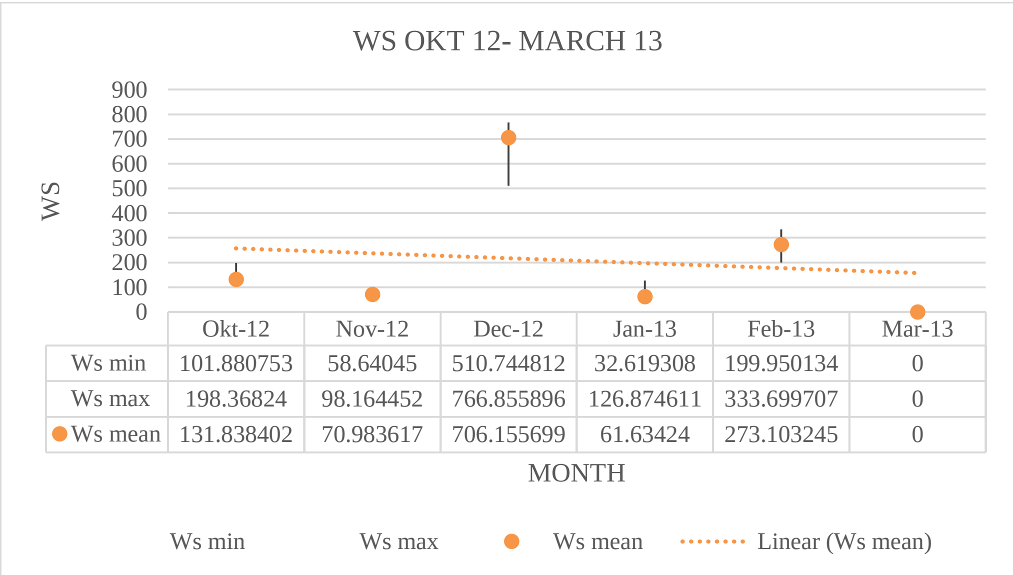
For October 2012 to March 2013, it can be clearly observed that the highest intensity of rainfall mean is 790.23 mm recorded on December 2012. While the minimum average rainfall for Kemaman is in March 2013 that is 0.00 mm (Figure 4.29).



	Okt-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13
AET min	78.682922	68.875206	61.914886	65.078667	66.027802	69.191582
AET max	113.800865	102.411263	88.807007	106.207794	102.094879	110.004333
AET mean	102.702036	94.438593	84.073925	97.359511	93.112581	103.008402

Figure 4.30 AET for Oct 2012 to March 2013

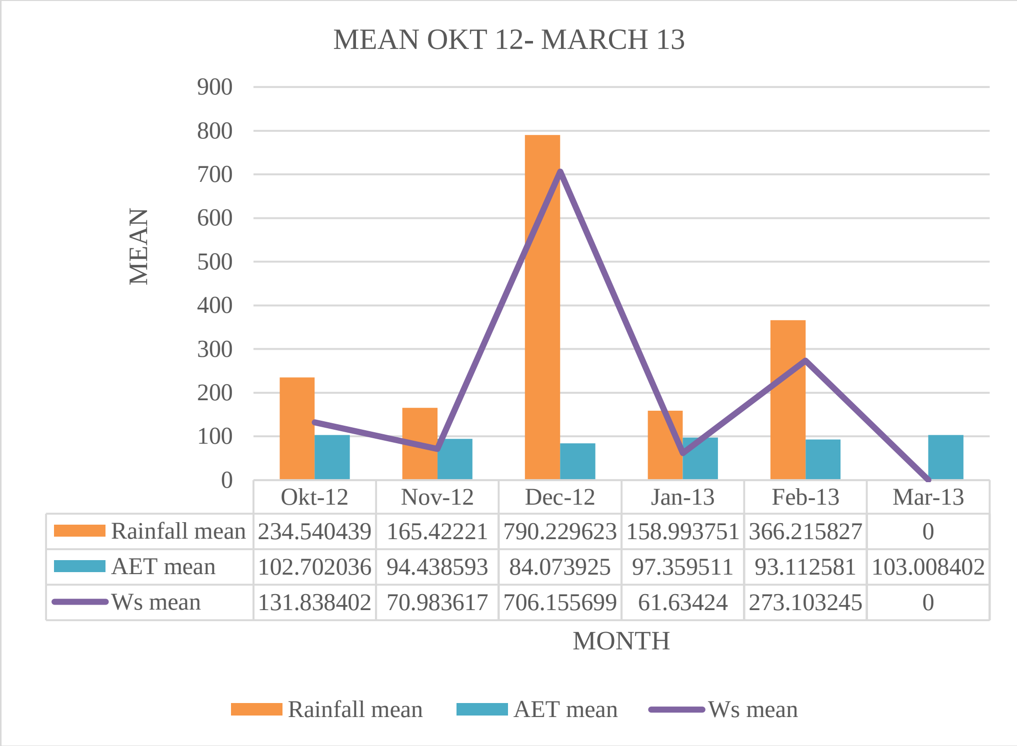
For October 2012 to March 2013, it can be clearly observed that the maximum average AET is 103.01 mm recorded in March 2013 while the minimum average AET is 84.07 mm recorded in December 2012 (Figure 4.30).



	Okt-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13
Ws min	101.880753	58.64045	510.744812	32.619308	199.950134	0
Ws max	198.36824	98.164452	766.855896	126.874611	333.699707	0
Ws mean	131.838402	70.983617	706.155699	61.63424	273.103245	0

Figure 4.31 Water Surplus for Oct 2012 to March 2013

For October 2012 to March 2013, it can be clearly observed that the average maximum Surplus for Kemaman is 706.16 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2012 while for the average minimum Surplus is recorded in March 2013 (Figure 4.31).



	Okt-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13
Rainfall mean	234.540439	165.42221	790.229623	158.993751	366.215827	0
AET mean	102.702036	94.438593	84.073925	97.359511	93.112581	103.008402
Ws mean	131.838402	70.983617	706.155699	61.63424	273.103245	0

Figure 4.32 Mean for Oct 2012 to March 2013

Figure 4.32 shows that in December 2012, there is average maximum rainfall that is 790.23 mm and average maximum Surplus that is 706.16 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (March 2013).

Table 4.9 Oct 2013- March 2014

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-13	386.8841	71.40622	110.9535	101.2991	187.7363	323.8072	285.5851
Nov-13	341.4854	72.98811	98.93111	89.09736	150.7645	347.232	252.388
Dec-13	949.2588	67.60969	107.7897	99.54741	728.5826	904.028	849.7114
Jan-14	197.5874	65.39504	110.0043	103.4185	51.56493	181.8307	94.16895
Feb-14	0.00	73.3045	110.9535	104.9434	0.00	0.00	0.00
Mar-14	0.00	66.97694	109.0552	98.84371	0.00	0.00	0.00

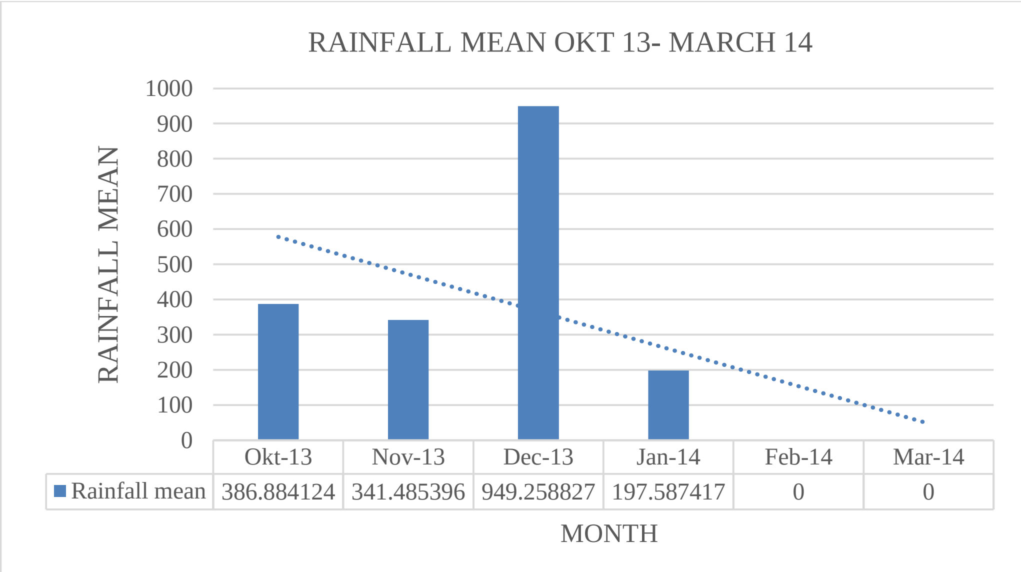


Figure 4.33 Rainfall Mean for Oct 2013 to March 2014

For October 2013 to March 2014, it can be clearly observed that the highest intensity of rainfall mean is 949.26 mm recorded on December 2013. While the minimum average rainfall for Kemaman is in February and March 2014 that is 0.00 mm (Figure 4.33).

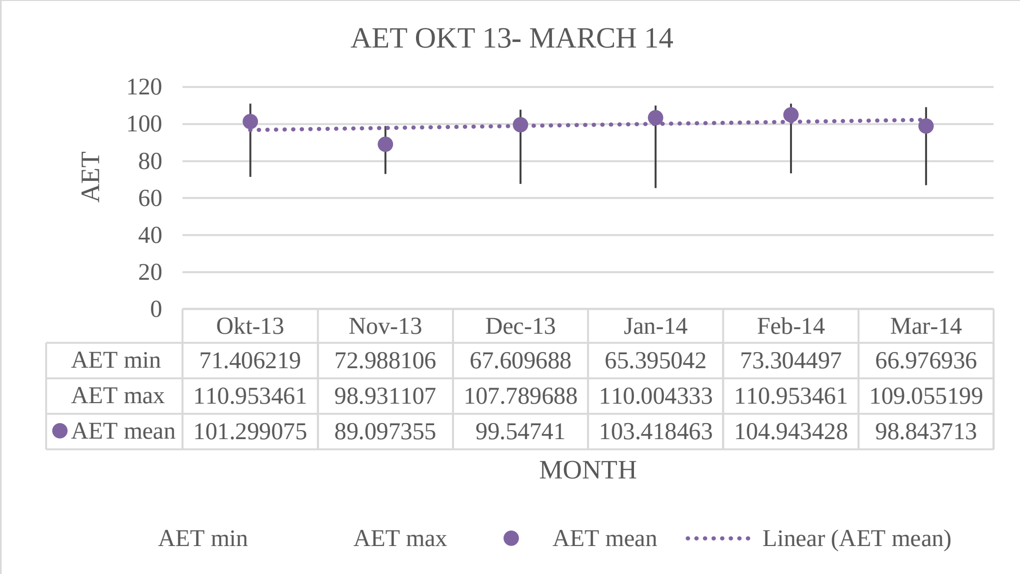


Figure 4.34 AET for Oct 2013 to March 2014

For October 2013 to March 2014, it can be clearly observed that the maximum average AET is 104.42 mm recorded in February 2014 while the minimum average AET is 89.10 mm recorded in November 2013 (Figure 4.34).

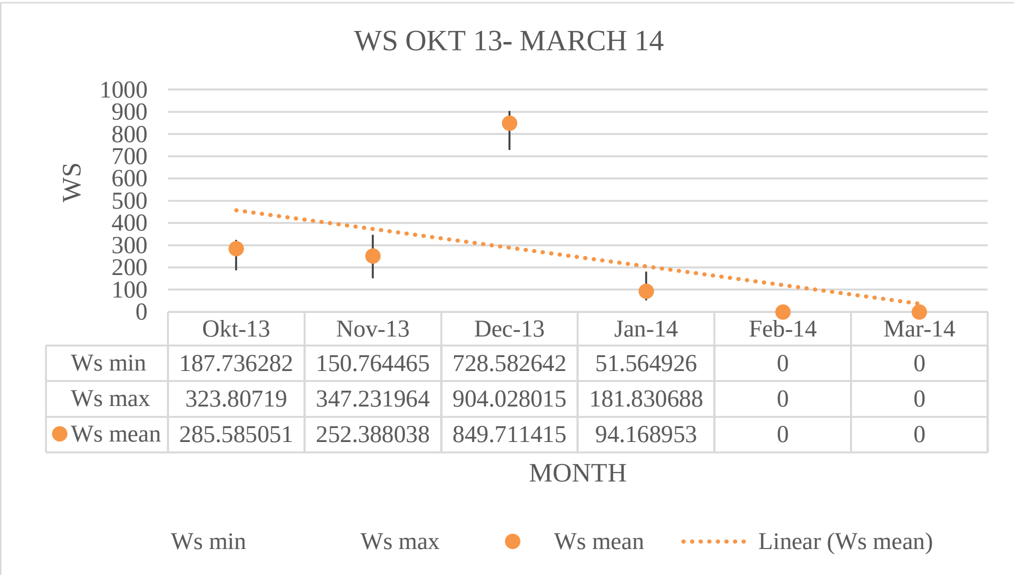


Figure 4.35 Water Surplus for Oct 2013 to March 2014

For October 2013 to March 2014, it can be clearly observed that the average maximum Surplus for Kemaman is 849.72 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2013 while for the average minimum Surplus is recorded in February and March 2014 (Figure 4.35).

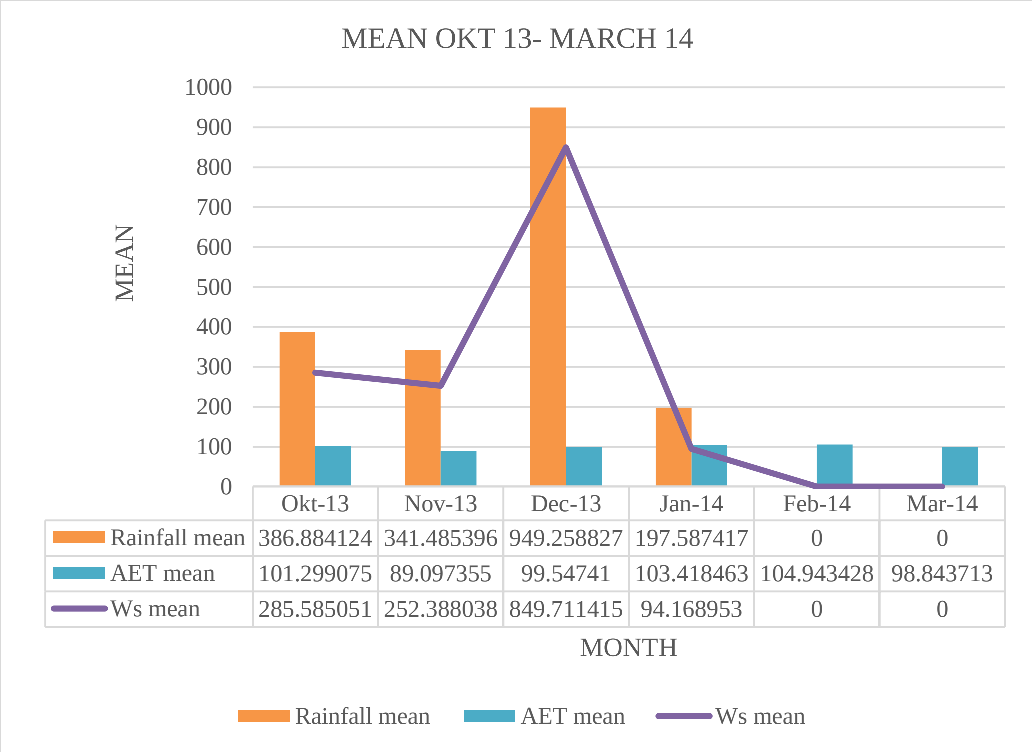


Figure 4.36 Mean for Oct 2013 to March 2014

Figure 4.36 shows that in December 2013, there is average maximum rainfall that is 949.26 mm and average maximum Surplus that is 849.71 mm while for the AET, it is recorded 89.10 mm and it is the average minimum AET (November 2013).

Table 4.10 Oct 2014- March 2015

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-14	252.955	76.78465	110.3207	104.1184	51.97569	217.4953	148.8699
Nov-14	441.6498	66.66055	105.2587	99.57072	232.7325	437.3569	341.9982
Dec-14	1477.797	64.44591	99.56386	91.95634	1257.643	1466.107	1385.869
Jan-15	125.8794	60.64937	108.4224	98.8224	10.68957	99.56798	27.04815
Feb-15	57.26728	65.71142	107.4733	98.79851	0.00	8.657478	0.00
Mar-15	1.289459	66.97693	108.1061	100.8701	0.00	0.00	0.00

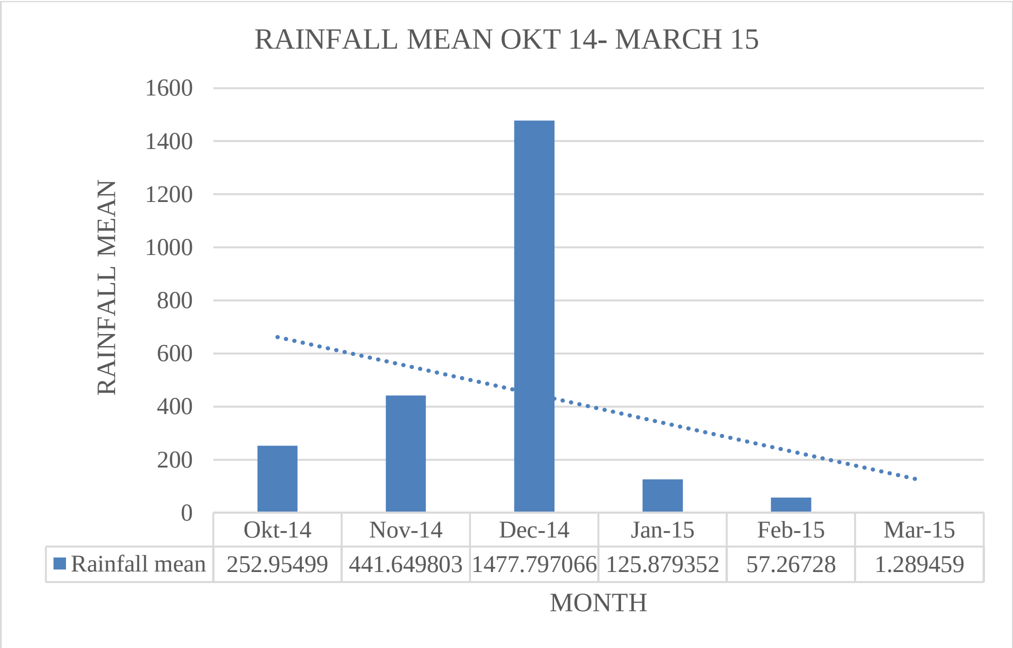
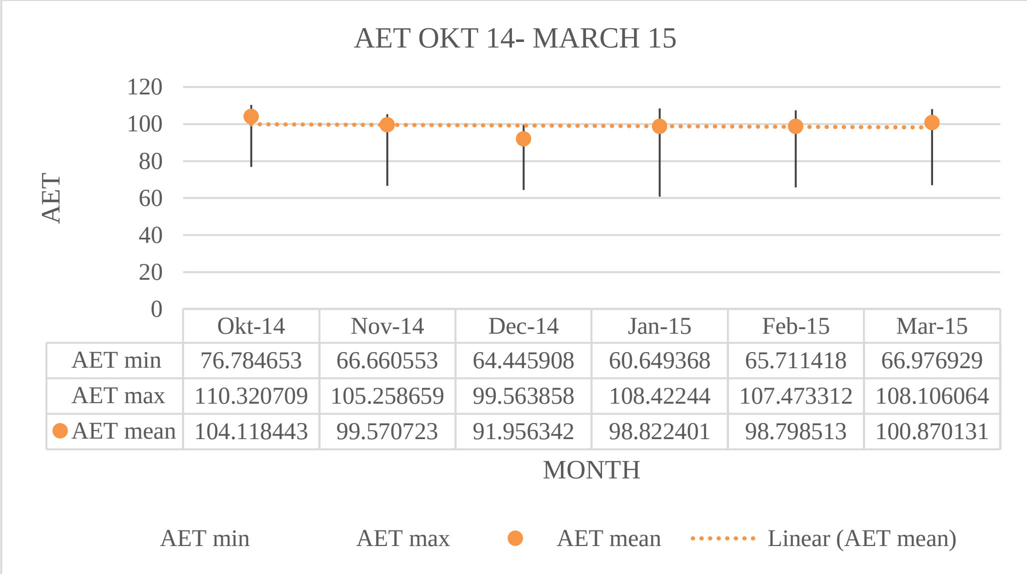


Figure 4.37 Rainfall Mean for Oct 2014 to March 2015

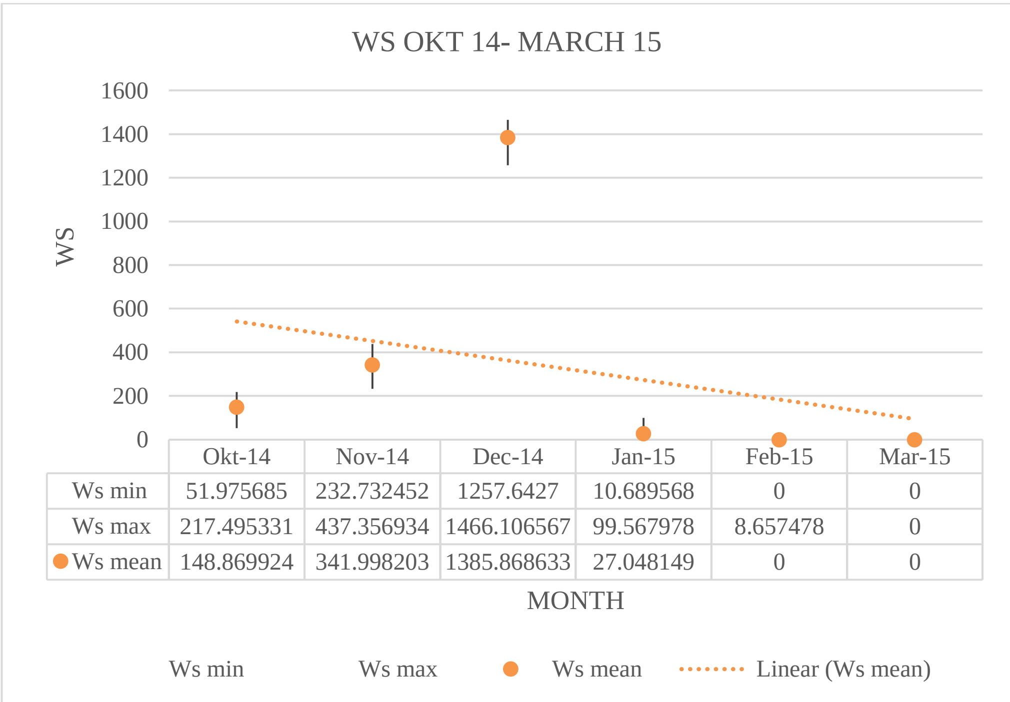
For October 2014 to March 2015, it can be clearly observed that the highest intensity of rainfall mean is 1477.80 mm recorded on December 2014. While the minimum average rainfall for Kemaman is in March 2015 that is 1.29 mm (Figure 4.37).



	Okt-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15
AET min	76.784653	66.660553	64.445908	60.649368	65.711418	66.976929
AET max	110.320709	105.258659	99.563858	108.42244	107.473312	108.106064
AET mean	104.118443	99.570723	91.956342	98.822401	98.798513	100.870131

Figure 4.38 AET for Oct 2014 to March 2015

For October 2014 to March 2015, it can be clearly observed that the maximum average AET is 104.12 mm recorded in October 2014 while the minimum average AET is 91.96 mm recorded in December 2014 (Figure 4.38).



	Okt-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15
Ws min	51.975685	232.732452	1257.6427	10.689568	0	0
Ws max	217.495331	437.356934	1466.106567	99.567978	8.657478	0
Ws mean	148.869924	341.998203	1385.868633	27.048149	0	0

Figure 4.39 Water Surplus for Oct 2014 to March 2015

For October 2014 to March 2015, it can be clearly observed that the average maximum Surplus for Kemaman is 1385.87 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in

December 2014 while for the average minimum Surplus is recorded in February and March 2015 (Figure 4.39).

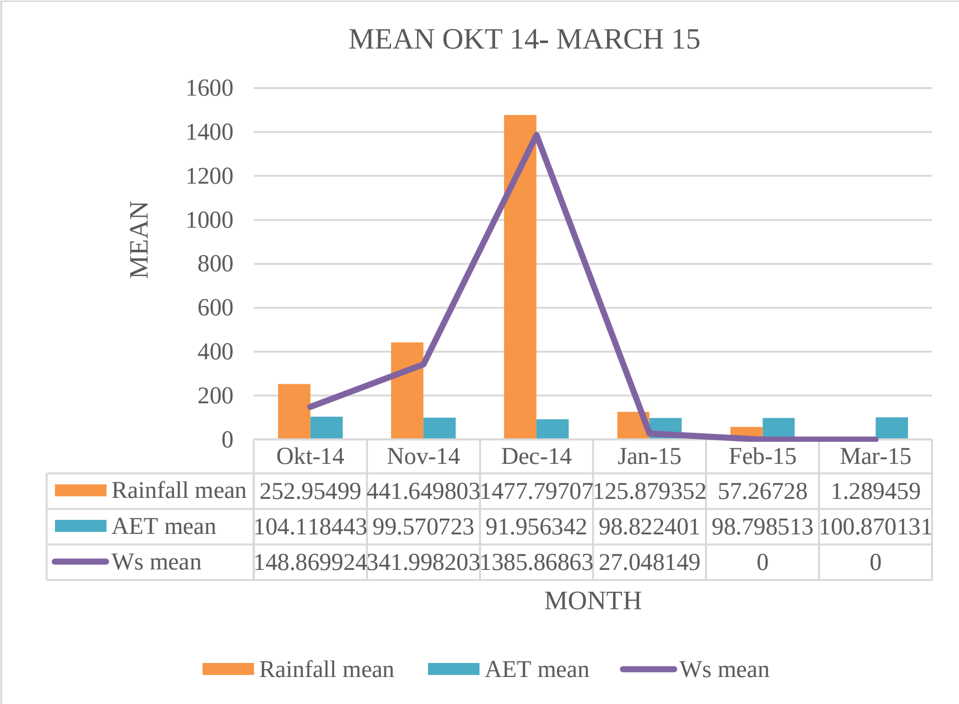


Figure 4.40 Mean for Oct 2014 to March 2015

Figure 4.40 shows that in December 2014, there is average maximum rainfall that is 1477.80 mm and average maximum Surplus that is 1385.87 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (February and March 2015).

Table 4.11 Oct 2015- March 2016

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-15	197.4326	58.11835	107.7897	94.86392	77.86308	151.4081	102.5322
Nov-15	278.0918	69.19157	104.3095	95.46038	133.5174	253.2916	182.6578
Dec-15	381.4541	66.34417	99.88023	95.79447	173.516	340.163	285.7552
Jan-16	0.00	73.62087	107.4733	98.53113	0.00	0.00	0.00
Feb-16	0.165789	67.60968	102.0949	91.98037	0.00	0.00	0.00
Mar-16	0.00	74.88638	107.7897	98.83484	0.00	0.00	0.00

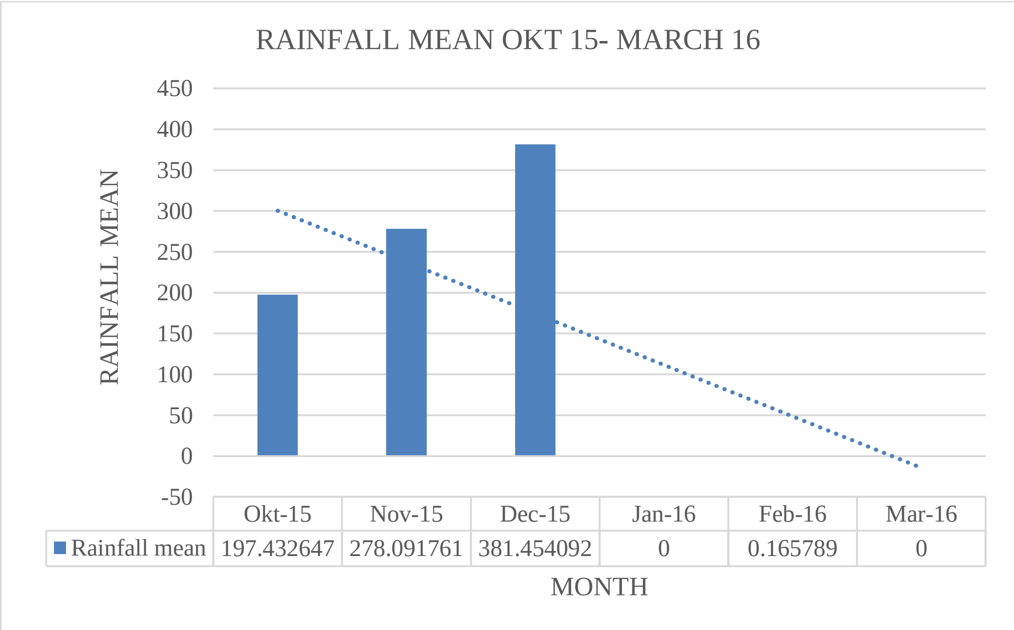
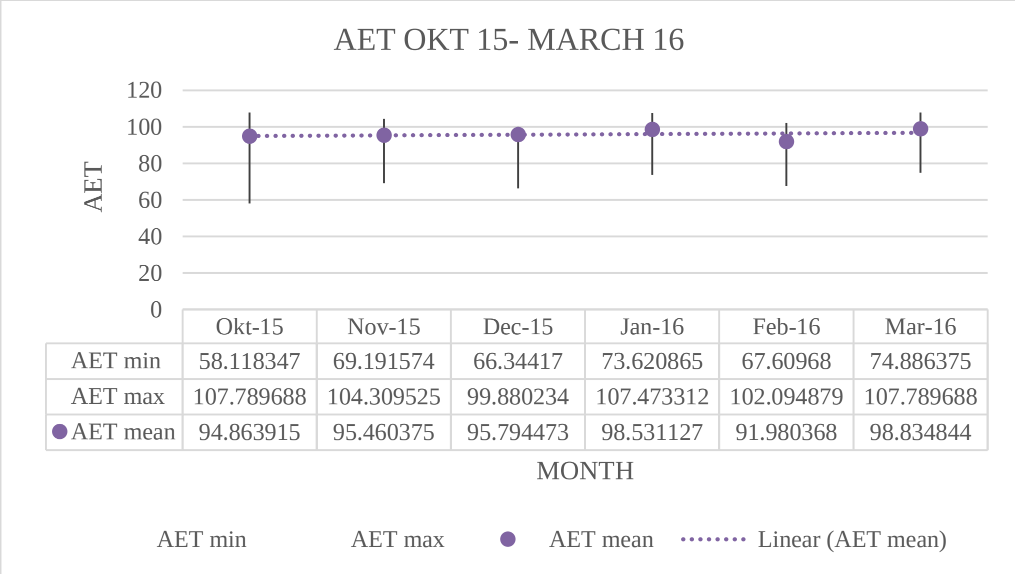


Figure 4.41 Rainfall Mean for Oct 2015 to March 2016

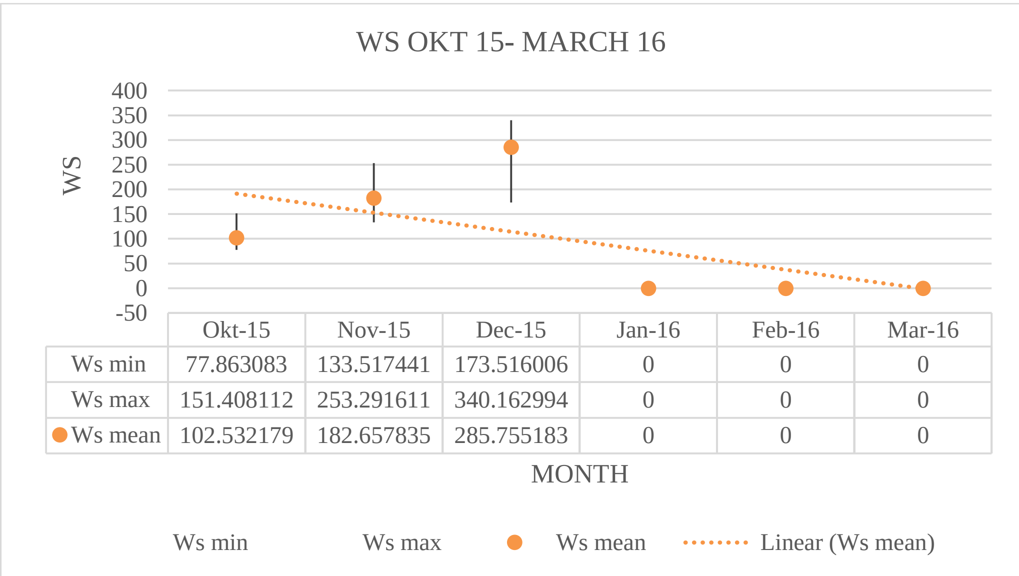
For October 2015 to March 2016, it can be clearly observed that the highest intensity of rainfall mean is 381.45 mm recorded on December 2015. While the minimum average rainfall for Kemaman is in January and March 2016 that is 0.00 mm (Figure 4.41).



	Okt-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16
AET min	58.118347	69.191574	66.34417	73.620865	67.60968	74.886375
AET max	107.789688	104.309525	99.880234	107.473312	102.094879	107.789688
AET mean	94.863915	95.460375	95.794473	98.531127	91.980368	98.834844

Figure 4.42 AET for Oct 2015 to March 2016

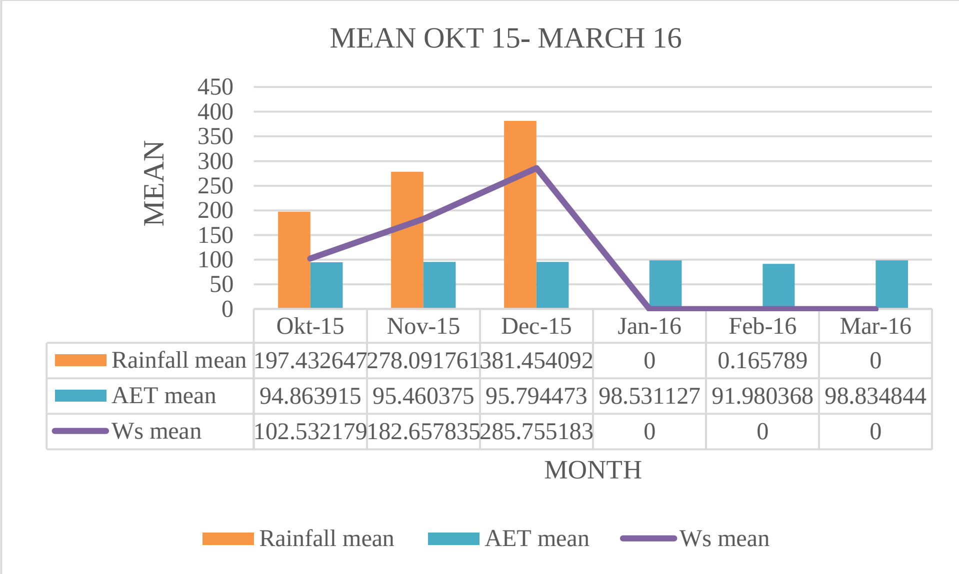
For October 2015 to March 2016, it can be clearly observed that the maximum average AET is 98.83 mm recorded in March 2016 while the minimum average AET is 94.86 mm recorded in October 2015 (Figure 4.42).



	Okt-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16
Ws min	77.863083	133.517441	173.516006	0	0	0
Ws max	151.408112	253.291611	340.162994	0	0	0
Ws mean	102.532179	182.657835	285.755183	0	0	0

Figure 4.43 Water Surplus for Oct 2015 to March 2016

For October 2015 to March 2016, it can be clearly observed that the average maximum Surplus for Kemaman is 285.76 mm and the average minimum Surplus for Kemaman is 0.00 mm. We can see that the average maximum surplus is recorded in December 2015 while for the average minimum Surplus is recorded in January, February and March 2016 (Figure 4.43).



	Okt-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16
Rainfall mean	197.432647	278.091761	381.454092	0	0.165789	0
AET mean	94.863915	95.460375	95.794473	98.531127	91.980368	98.834844
Ws mean	102.532179	182.657835	285.755183	0	0	0

Figure 4.44 Mean for Oct 2015 to March 2016

Figure 4.44 shows that in December 2015, there is average maximum rainfall that is 381.45 mm and average maximum Surplus that is 285.76 mm while for the AET, it is recorded 0.00 mm and it is the average minimum AET (January, February and March 2015).

4.2 Hydrology Data

Northest Monsoon Season (NEM) which occurs annually from November to March. Extra rainfall occurs in the East Coast of Malaysia during the NEM which affects Kelantan, Terengganu and Pahang states.

Table 4.11 shows that the maximum rainfall mean are major in December 2013 (949.26 mm) and the average minimum evapotranspiration rate is in November 2013 (89.10 mm). For the water surplus, the maximum recorded are major in December 2014 (849.71) which is in northeast monsoon.

Table 4.12 Rainfall, AET and Water Surplus for October 2013 to March 2014

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-13	386.8841	71.40622	110.9535	101.2991	187.7363	323.8072	285.5851
Nov-13	341.4854	72.98811	98.93111	89.09736	150.7645	347.232	252.388
Dec-13	949.2588	67.60969	107.7897	99.54741	728.5826	904.028	849.7114
Jan-14	197.5874	65.39504	110.0043	103.4185	51.56493	181.8307	94.16895
Feb-14	0.00	73.3045	110.9535	104.9434	0.00	0.00	0.00
Mar-14	0.00	66.97694	109.0552	98.84371	0.00	0.00	0.00

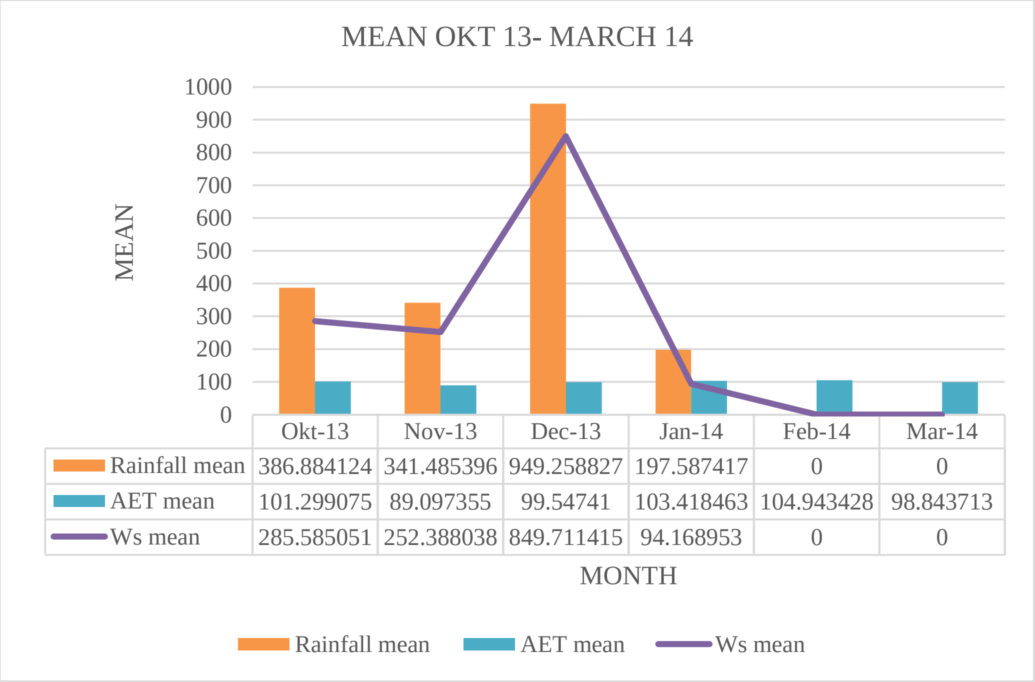


Figure 4.45 Mean for Oct 2013 to March 2014

As seen in Figure 4, the highest rainfall distribution in December 2013 (949.26 mm), meanwhile in second highest rainfall is October 2013 (386.88 mm). The average for actual-evapotranspiration in December 2013 (99.55 mm) and October 2013(101.30mm).The analysis shows water-yield in December 2013 is the highest among others (849.71) mm.

Table 4.13 Rainfall, AET and Water Surplus for October 2014 to March 2015

Month	Rainfall mean	AET min	AET max	AET mean	Ws min	Ws max	Ws mean
Okt-14	252.955	76.78465	110.3207	104.1184	51.97569	217.4953	148.8699
Nov-14	441.6498	66.66055	105.2587	99.57072	232.7325	437.3569	341.9982
Dec-14	1477.797	64.44591	99.56386	91.95634	1257.643	1466.107	1385.869
Jan-15	125.8794	60.64937	108.4224	98.8224	10.68957	99.56798	27.04815
Feb-15	57.26728	65.71142	107.4733	98.79851	0.00	8.657478	0.00
Mar-15	1.289459	66.97693	108.1061	100.8701	0.00	0.00	0.00

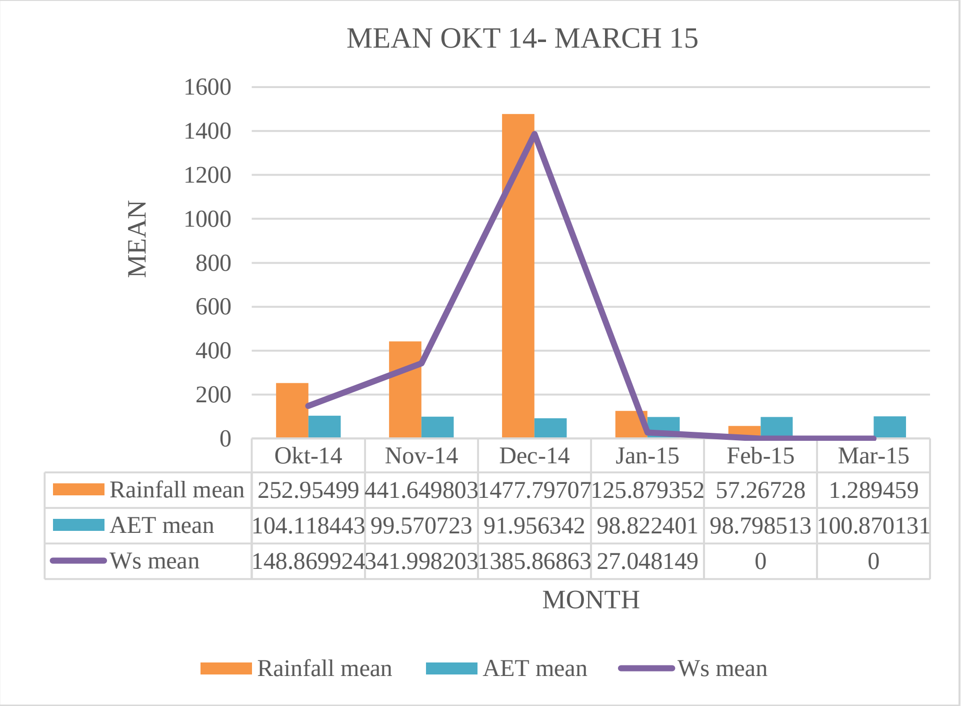


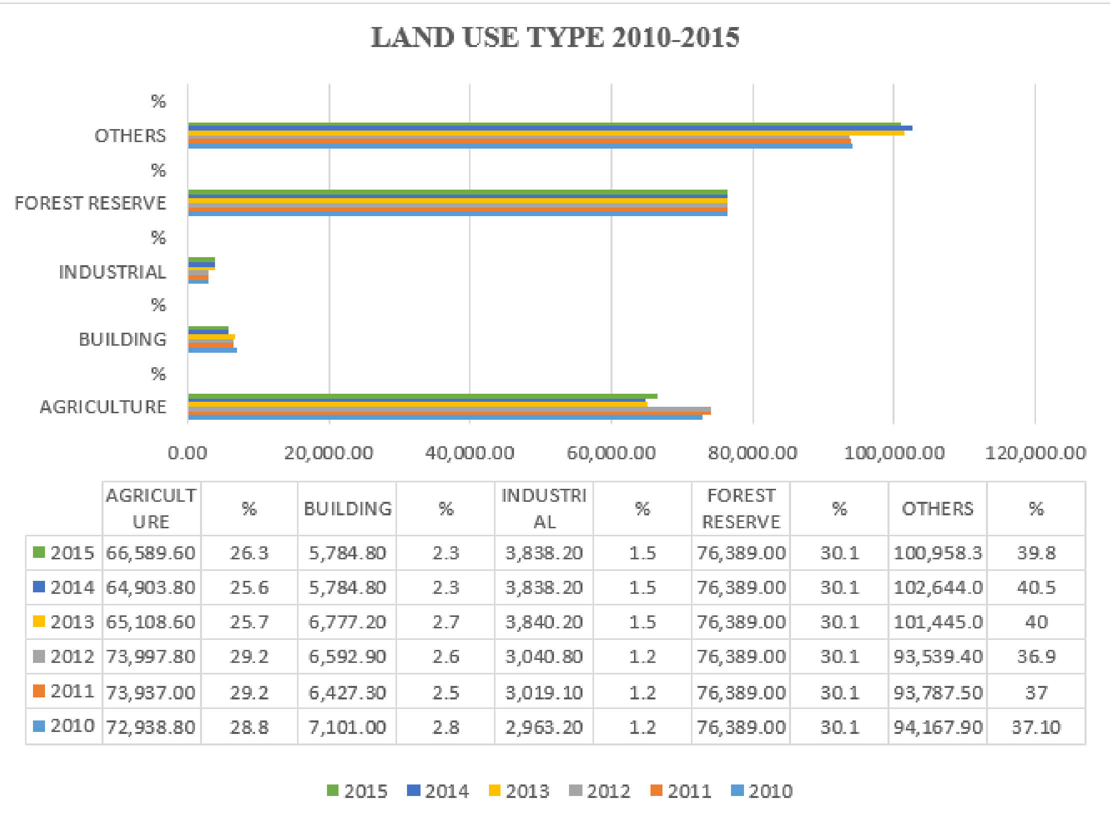
Figure 4.46 Mean for Oct 2014 to March 2015

As seen in Figure 4.46 and Table 4.12, the highest rainfall distribution in December 2014 (1477.80 mm), meanwhile in second highest rainfall is November 2014 (441.65 mm). The average for actual- evapotranspiration in December 2014 (91.96 mm) and November 2014(99.57 mm). The analysis shows water-yield in December 2014 is the highest among others (1385.87) mm.

4.3 Land Use Land Cover Status

Table 4.14 Land Use Land Cover for Kemaman

Year	Agriculture	%	Building	%	Industrial	%	Forest Reserve	%	Others	%
2010	72,938.8	28.8	7,101.0	2.8	2,963.2	1.2	76,389.0	30.1	94,167.9	37.1
2011	73,937.0	29.2	6,427.3	2.5	3,019.1	1.2	76,389.0	30.1	93,787.5	37.0
2012	73,997.8	29.2	6,592.9	2.6	3,040.8	1.2	76,389.0	30.1	93,539.4	36.9
2013	65,108.6	25.7	6,777.2	2.7	3,840.2	1.5	76,389.0	30.1	101,445.0	40.0
2014	64,903.8	25.6	5,784.8	2.3	3,838.2	1.5	76,389.0	30.1	102,644.0	40.5
2015	66,589.6	26.3	5,784.8	2.3	3,838.2	1.5	76,389.0	30.1	100,958.3	39.8



	AGRICULTURE	%	BUILDING	%	INDUSTRIAL	%	FOREST RESERVE	%	OTHERS	%
2015	66,589.60	26.3	5,784.80	2.3	3,838.20	1.5	76,389.00	30.1	100,958.3	39.8
2014	64,903.80	25.6	5,784.80	2.3	3,838.20	1.5	76,389.00	30.1	102,644.0	40.5
2013	65,108.60	25.7	6,777.20	2.7	3,840.20	1.5	76,389.00	30.1	101,445.0	40
2012	73,997.80	29.2	6,592.90	2.6	3,040.80	1.2	76,389.00	30.1	93,539.40	36.9
2011	73,937.00	29.2	6,427.30	2.5	3,019.10	1.2	76,389.00	30.1	93,787.50	37
2010	72,938.80	28.8	7,101.00	2.8	2,963.20	1.2	76,389.00	30.1	94,167.90	37.10

Figure 4.47 Land Use Land Cover Type from 2010 to 2015 source from Pejabat Tanah dan Galian Negeri Terengganu

As seen in Figure 4.47 and Table 4.13 the percentage of agriculture is decreased from 25.7% to 25.6% for the year 2013 and 2014. There is also a decrement for building from 2.7% to 2.3% for the year 2013 and 2014. There is an increment for other that is 40% for 2013 and 40.5% for 2014.

Table 4.15 Land Use Land Cover Type

Year	Develop/Bare	%	Shrub/crop	%	Crop	%	Forest	%
2013	217166143	9.11	91376100	26.87	171049500	50.31	46592957	13.70
2014	53624734	11.07	244945800	50.56	154998000	31.99	30908666	6.38

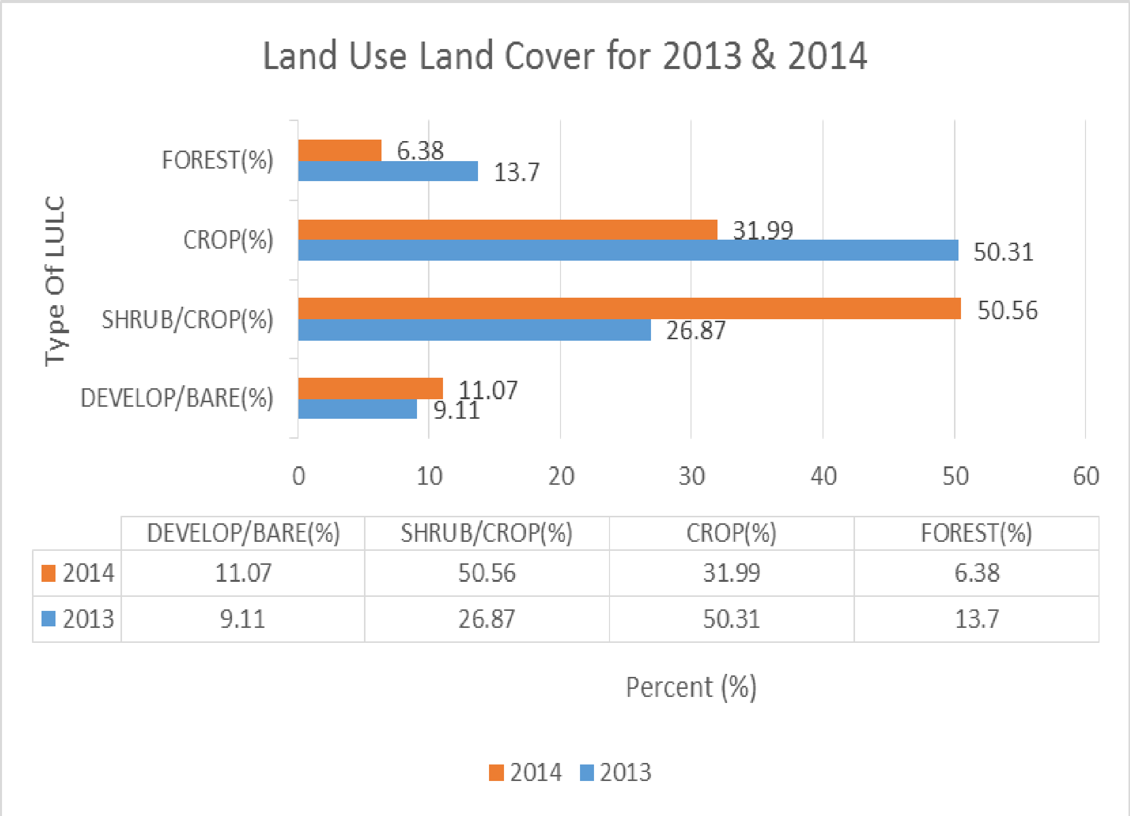


Figure 4.48 Land Use Land Cover Type from 2013 and 2014

Figure 4.48 and Table 4.14 show the analysis from image satellite that the percentage of the crop is decreased from 50.31% to 31.99% for the year 2013 and 2014. There is also a decrement for forest from 13.70% to 6.38% for the year 2013 and 2014. There is an increment for develop or bare that is 9.11% for 2013 and 11.07% for 2014. In addition, there is an increment for shrub crop 26.87% for 2013 and 50.56% for 2014.

The analysis shows in December 2014 flood was greater than the flood in December 2013. This is due to the high intensity of rainfall 1477.8 mm and 94% (1385.9 mm) from the product water. In addition, a reduction in stand LULC vegetative (11.07% in 2013 to 9.11% in 2014) due to crop and replanting activities is shown by the reduction of AET (99.55 mm in 2013 and 91.96 mm in 2014).

4.4 Number of Victims Data

Figure 4.49 Number of Victims for 2013

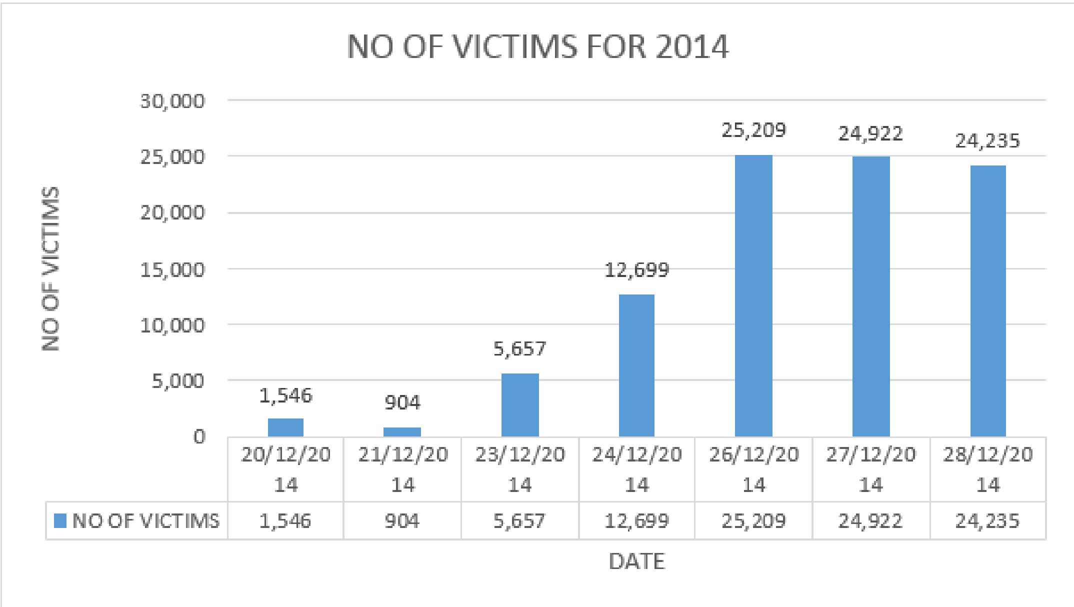


Figure 4.50 Number of Victims for 2014

Figure 4.49 and Figure 4.50 shows that the total number of victims is the highest recorded on 26 December 2014. The number of victims is 25,209. The second highest total number of victims recorded on 27 December 2014 that is 24,922. The third highest total number of victims recorded on 28 December 2014 that is 24,235.In overall, total number of victims for 2013 is 81,625.00 and for year 2014 is 95,172.00. Number of victims for year 2014 is higher than 2013.

CHAPTER 5

CONCLUSION

5.1 Introduction

This part elucidated the conclusion and suggestion for in general of the part before in the research. Essentially, the conclusion for the review is to express the results that based on the goal of the study which was to analyse the rainfall, actual evapotranspiration (AET) and water surplus (water-yield) in Kemaman River Basin, and to analyse the LULC impact on flood in Kemaman River Basin.

5.2 Conclusion

The analysis shows in December 2014 flood was greater than the flood in December 2013. This is due to the high intensity of rainfall 1477.8 mm and 94% (1385.9 mm) from the product water. For year 2013 the intensity of rainfall is 949.2588 mm and 89.51% (849.7114) from the product water. In addition, a reduction in stand LULC vegetative (11.07% in 2013 to 9.11% in 2014) due to crop and replanting activities is shown by the reduction of AET (99.55 mm in 2013 and 91.96 mm in 2014).

The total number of victims is the highest recorded on 26 December 2014. The number of victims is 25,209. The second highest total number of victims recorded on 27 December 2014 that is 24,922. The third highest total number of victims recorded on 28 December 2014 that is 24,235.In overall, total number of victims for 2013 is 81,625.00 and for year 2014 is 95,172.00. Number of victims for year 2014 is higher than 2013.

5.3 Future Recommendation

There is an impact of land use land cover on floods in Kemaman River Watershed; this study can be additionally enhanced with different aspects. Some of the recommended studies for the future are as follow:

i) It is recommended replanting scheme is taken into account in the design of non-structure flood mitigation. Management and control of flood water movement such as redirecting flood run-off through the use of floodwalls and flood gates, rather than trying to prevent flood altogether.

ii) Flood-proofed. Identifying home-flood plain area.

iii) Environmentally sensitive area protection.

iv) Flood forecasting and warning methods.

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