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DEVELOPMENT OF AN INTEGRATED SPATIAL DISTRIBUTED TRAVEL TIME METHOD USING GIS TO MODEL RAINFALL RUNOFF IN BENTONG CATCHMENT, MALAYSIA

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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Chairman : Professor Wan Nor Azmin Sulaiman, PhD
Faculty : Environmental Studies

Rainfall runoff (RR) modelling over a catchment wide basis is a challenging task. The emerging of GIS technology has make the usage of distributed GIS more convenient nowadays. There many types of distributed model but in this study, it is performed using combination of kinematic wave approximation (KWA) and manning's equation along with National Resources Conservation Services Curve Number (NRCS CN) to provide the estimation of effective rainfall. This study proposed an improved method by introducing the usage of new way to route the overland flow with enhancing the applicability of Digital Elevation Model (DEM) characteristics. One of parameter used in KWA calculation is distance a flow path or ridges, x (m). Previously, most models used assumption or estimated input namely overland flow, L and length of slope, ls to be applied for the whole grids. This approach deems not fully suit with the term distributed model, which every single grid supposedly has their own unique value. Therefore, an improvement proposed by multiplying the rainfall intensity with the longest perpendicular distance in a grid. Then, to predict discharge at the outlet, time area (TA) approach is applied. This model named as Spatial Distributed Travel Time (SDTT) in this study. Besides SDTT, spatial lumped model (SLM) is also applied to compare the result of both model. From DEM resolution and sensitivity analysis (SA), it is determined that using 30 m DEM size with input of x equal to 42.2 m gave the best predicted hydrograph. Using coarser DEM resolution increase the peak discharge and shorten the time to peak. SDTT model performed better than SLM when compared to the observed discharge. For calibration, SDTT gave result of NSE = 0.86; PBIAS = -1.95; r = 0.87 ($p<0.0001$) and SLM produce NSE = 0.78; PBIAS = -21.58; r = 0.85 ($p>0.0001$). In validation, SDTT result NSE = 0.81; PBIAS = 0.17; r = 0.88 ($p<0.0001$) and SLM produce NSE = 0.62; PBIAS = 15.87; r = 0.85 ($p<0.0001$). Furthermore, SDTT also perform better in predicting peak discharge (PD and time to peak (TP) compare to SLM. Land use land cover change (LULC) effect on flood hydrology of Bentong catchment

also indicate there is significant of LULC changes from period of 2000 to 2016 found out through Chi- square goodness of fit test with result (χ^2 = 7.403, p –value = 0.0006 (P <0.05)). There is also significant increase of peak discharge and decrease in time to peak and travel time.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBANGUNAN MODEL INTEGRASI RERUANG WAKTU PERJALANAN TERAGIH MENGGUNAKAN GIS UNTUK MEMODELKAN LARIAN AIR HUJAN DI LEMABANGAN BENTONG, SEMENANJUNG MALAYSIA

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Kajian ini memberi penekanan kepada model bergrid dengan menggunakan gabungan persamaan KWA dan persamaan *manning* bersama NRCS CN untuk memberikan anggaran hujan berkesan. Kajian ini telah mencadangkan kaedah yang lebih baik dengan memperkenalkan penggunaan cara baru untuk mengalir aliran darat dengan meningkatkan kebolehgunaan ciri-ciri DEM. Sebelum ini, kebanyakan model menggunakan andaian atau anggaran input iaitu aliran darat, *L* dan panjang cerun, *ls* untuk digunakan bagi keseluruhan grid. Pendekatan ini tidak menepati dengan model bergrid, yang setiap grid akan mempunyai nilai yang unik. Oleh itu, peningkatan adalah dicadangkan dengan mengubah persamaan sebelumnya untuk mengira aliran darat. Model ini dinamakan sebagai *Spatial Travel Time Distributed* (SDTT) dalam kajian ini. Selain SDTT, *spatial lumped model* (SLM) juga digunakan untuk membandingkan hasil kedua-dua model. Keputusan dari resolusi dan analisis kepekaan DEM (SA), menunjukkan bahawa menggunakan saiz DEM 30 m dengan input *x* sama dengan 42.2 m memberikan hidrograf ramalan yang terbaik. Penggunaan resolusi DEM kasar meningkatkan puncak pelepasan dan mempercepatkan masa ke puncak. Model SDTT didapati lebih baik daripada SLM. Untuk penentukuran, SDTT memberikan keputusan NSE = 0.86; PBIAS = -1.95; r = 0.87 (p <0.0001) dan SLM menghasilkan NSE = 0.78; PBIAS = -21.58; r = 0.85 (p> 0.0001). Dalam pengesahan, SDTT memberikan keputusan NSE = 0.81; PBIAS = 0.17; r = 0.88 (p <0.0001) dan SLM menghasilkan NSE = 0.62; PBIAS = 15.87; r = 0.85 (p <0.0001). Tambahan pula, SDTT juga menunjukkan prestasi yang lebih baik dalam meramal pelepasan puncak (PD) dan masa ke puncak (TP) jika dibandingkan dengan SLM dengan R^2 0.975 dan 0.8274. Kesan perubahan perlindungan tanah (LULC) tanah di hidrologi banjir di kawasan Bentong juga menunjukkan bahawa terdapat banyak perubahan LULC dari tempoh 2000 hingga 2016 melalui ujian kebaikan Chi-square dengan hasil (χ^2 = 7.403, p -value = 0.0006 (p <0.05)). Berdasarkan ujian korelasi, korelasi negatif

antara TP dan PD, r = -0.993 (p = 0.078) dan PD dan Tt dengan r = -0.995 (p = 0.067). Namun terdapat korelasi yang positif antara TP dan Tt, r = 0.974 = 0.144). Terdapat juga korelasi yang positif antara TP dan Tt, r = 0.988 (p = 0.099). Masa perjalanan dari tahun 2000 hingga 2016 juga berkurangan selama 2.5 hingga 3.5 jam.

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I certify that a Thesis Examination Committee has met on 30 March 2018 to conduct the final examination of Mohd Hafiz bin Rosli on his thesis entitled "Development of an Integrated Spatial Distributed Travel Time Method Using GIS to Model Rainfall Runoff in Bentong Catchment, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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- the research conducted and the writing of this thesis was under our supervision;
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LIST OF ABBREVIATIONS

GIS	Geographic Information Systems
NRCS CN	National Resources Conservation Services Curve Number
SDTT	Spatial Distributed Travel Time
SLM	Spatial Lumped Model
DEM	Digital Elevation Model
DOA	Department of Agriculture
DID	Department of Irrigation
LESTARI	Institute of Environment and Development
NSE	Nash Sutcliffe Efficiency
R^2	Coefficient of Determination
PBIAS	Percent of Bias
HEC-HMS	Hydrologic Engineering Centre- Hydrologic Modeling System
.shp	Shapefile
WHAT	Web Based Hydrograph Analysis Tool
LiDAR	Light Detection and Ranging
HSG	Hydrologic Soil Group
AMC	Antecedent Moisture Content
SRTM	Shuttle Radar Topography Mapping
InSAR	Interferometry Synthetic Aperture Radar
JUPEM	Department of Survey Malaysia
ESRI	Environmental System Research Institute

CRWR	Center for Research in Water Resources
TauDEM	Terrain Analysis Using Digital Elevation Models in Hydrology
HI	Hypsometric Index
SDUH	Spatially Distributed Unit Hydrograph
TA	Time Area
TAD	Time Area Diagram
USACE	United States Army Corps of Engineers
CUH	Clark Unit Hydrograph
SA	Sensitivity Analysis
MSMA	Urban Stormwater Management Manual for Malaysia
SCS	Soil Conservation Services
N_u	Stream Order
L_u	Stream Length
L_{sm}	Mean Stream Length
R_l	Stream length ratio
L_b	Basin Length
D_d	Drainage density
F_s	Stream frequency

D_t	Drainage texture
F_f	Form factor
R_c	Circularity ratio
R_e	Elongation ratio
HI	Hypsometric Index
IDW	Inverse Distance Weight
NEH	National Engineering Handbook
USDA	United States Department of Agriculture
WGS84	World Geodetic System 1984
TP	Time to peak
PD	Peak discharge
Tt	Travel time
KWA	Kinematic wave assumption

CHAPTER 1

INTRODUCTION

1.1 Introduction

Floods is known as the most catastrophic natural hazards and occurred frequently in many parts of the regions in this world. The flooding issue is being highlighted as the most destructive natural hazards (UN, 2004; Sun et al, 2017) as it can destroy the environment, socio-economic condition, human livelihood and their properties. The impact of flood hazards is enormous at the global scale (Berz et al, 2001; Hajat et al, 2003; Ahern et al., 2005; Jonkman, 2005; Jonkman and Vrijling, 2008; Romshoo et al., 2012). Flooding is responsible for more than one – third of the total estimated costs incurred and two – third of the affected people due to natural disasters (Coates, 1999; UN 2004; Jonkman and Kelman, 2005; Jonkman, 2005; Re, 2007). The flood hazards is mainly caused by the anthropogenic human activities such as deforestation (Barasa and Perera., 2018), rapid urbanization and uncontrolled land development land use change (Gigović et al., 2017). These factors of flood hazards is arise due to the population growth and migration of population to coastal areas and river valleys (Arsiso et al., 2017) which subsequently increased in the global temperature due to the effects of climate change (Parry et al., 2007). Therefore, in such situation, the spatial and temporal dimensions of flood threat had trigger the related agencies bodies on how to minimize the impact of flood consequences such as human and economic losses at international scale (Arsiso et al., 2017).

Flash floods is one of the type of flood that occurred frequently in or close to upstream runoff generating areas and are characterized by rapid release of water from a catchment (Bout and Jetten, 2018). Flash floods often take place within a few hours of rainfall event and often lasting less than a day. Therefore, the basin or watershed modelling has become widely used and offered with various type of models with the purpose to simulating the rainfall runoff model within the catchment area. Previously, lumped based model had been widely used to model rainfall runoff in watershed sized basis. However, lumped model represents the catchment as a single unit. They are characterized by minimal data requirement which is averaged over the catchment. In these types of models, the parameter values are determined through calibration, not from the physical behaviours of the catchment (Wakigari, 2017). In addition, the spatial inhomogeneities of the input variables and parameters are not represented which limit their capability to simulate all the hydrological processes of catchment. Thus, only the dominant ones are properly described.

Nowadays, the application of spatial technology, geographic information system (GIS) and remote sensing (RS) have been widely used as the computer technology evolved. Distributed based hydrological model has rapidly emerged due to the extensive application of spatial technology. Distributed models characterize the catchment in details, unfortunately the required of intensive data are not available in most developing countries (Sandholt et al., 2002). Distributed hydrological models represent the heterogeneity of the catchment by considering the spatial variability of hydrometeorological variables, topography, geology, soil type and land use. Nevertheless, due to their complexity, long computation time and enormous data requirement lead them to have a limited practicality in most contexts (Carcano et al., 2008).

1.2 Problem Statement

Flash flood is frequently occurred in urban area due to the rapid urbanization and development which lead to the high number of impervious surface and subsequently reduce the infiltration process and generate the high volume of surface runoff. However, the rural area such as Bentong catchment also has been described as the prone area of flash flood due to the land use land cover change and climate change. In year of 2002 and 2004, a disastrous flood had occurred within the Bentong catchment which leads to a high damage of properties. Recently, in year 2010, flash flood once again struck heavily the catchment. Based on DID report, it was determined that the short period and heavy intense rainfall is the main cause of the flood occurrence. Thus, the critical study on flood hazards issue and hydrological process aspect is crucial and highly required in order to determine the rainfall-runoff characteristics within the Bentong catchment by highlighting on land use land cover change.

The watershed model can be categorized into two main classes known as lumped and distributed based model. Lumped based model is spatially averaged, or regarded as a single point in space without dimensions; they ignore the internal spatial variation of watershed flow while distributed model consider the hydrologic processes taking place at various points in space and define the model variables as functions of the space dimensions. However, the application of lumped based model in hydrologic model is mainly used to simulate rainfall-runoff on catchment wide basis (Halwatura and Najim, 2013; Széles et al., 2016; Jian et al., 2017). This scenario also occurred in Malaysia as most of the previous study carried out by Shamsudin and Hashim (2002) and El – Shafie et al (2011) are still using the application of lumped based model at Layang catchment in Johor state and Klang river basin, respectively.

There are also few attempts from various researchers such as Kang and Merwade (2011); Sinha et al (2016) and Fenicia et al (2016) performing rainfall-runoff by using distributed model approach. However, in certain cases, it might not be considered as a fully distributed model if there are few parameters used a constant value or average value in the model analysis. The application of distributed model approach in rainfall-runoff model has been used widely in terms of continuous rainfall event such as daily rainfall data at global scale (Suliman et al., 2014; Sinha et al., 2016). Therefore, in such situation, this study will introduce an event based rainfall-runoff model to ameliorate flash flood issue that has become frequent and major threats to the human lives including their socio-economic condition and properties in the rural area specifically in Bentong catchment, Pahang, Malaysia. Currently, the hydrological modeling by using the event based rainfall input in distributed model is very lacking in Malaysia.

Although there are many distributed based model available, many studies applied distributed model on continuous model. This study was focusing on event based model that is important to develop a flood hazard map as it represent the real condition (Diakikis, 2011). One of the main challenges for GIS based event model is the flood routing method Kalogeropoulos et al., (2013). This study had introduced a combination of kinematic wave approximation (KWA) and manning's equation along with NRCS CN to model rainfall runoff of Bentong catchment in a fully distributed based approach. Previous study by several researchers used the kinematic wave equation by integrating the overland flow, *L* (Maidment, 1996) and length of slope, *ls* (Gioti et al., 2013; Chalkias et al., 2016). However, the problem when using this approach, the input will be at the same and implemented to all grid without taking consideration the resolution size. This condition will not fully represent distributed based model and effect the results of the modeling. This study introduce solution for this problem which is by introducing KWA in order to calculate flow velocity in every cell without neglecting the DEM resolution characteristic. In this process, the depth of flow at equilibrium equation was modified from (Overton and Meadows, 1976) with manning equation (Eq.1.1).

$$\boldsymbol{V_0} = \frac{(\boldsymbol{i_e} \ast \boldsymbol{x})^{\mathbf{0.4}} \ast \boldsymbol{S_0}^{\mathbf{0.3}}}{\boldsymbol{n}^{\mathbf{0.6}}} \qquad \text{Eq.1.1}$$

Where y is the depth of runoff flow at equilibrium (m), i.e. the rainfall excess intensity (m/s), n the manning roughness coefficient, $\boldsymbol{x}$ is the distance along the flow path (m) and $\boldsymbol{S_0}$ the slope (m/m). Equation 1.1 will be used in the calculation of overland flow. Details equation generation available in section 3.8.1.1. In order to determine *x* value, DEM resolution analysis and sensitivity analysis will be performed. This step will be able to determine the most fitted *x* value for Bentong catchment because using inappropriate *x* value will affect result especially on time to peak.

One of challenges when using distributed model is to create the hydrograph at the output. Previous studies by (Diakikis, 2011) create hydrographs by using time are (TA) approach. Conversion of TA histograms to hydrographs by converting area to discharge was done by applying a 1 mm uniform rainfall and dividing by the associated time segment (Usul and Yilmaz, 2002; Noorbakhsh et al., 2005; Diakikis, 2011). In this study modification is made by using real rainfall intensity was used instead of using 1 mm uniform rainfall.

This study will be acknowledged as a pioneer study in Malaysia that applies a fully distributed GIS to model rainfall-runoff simulation. The recent flash flood hazard map will be produced by using time area (TA) approach in order to classify the runoff according to specific time. Moreover, a newly proposed method to improve the route, the overland and channel flow will be introduced in this study by combining the kinematic wave approximation and manning's equation distributed model which considered the hydrologic processes taking place at various points in space and define the model variables as functions of the space dimensions. In addition, the flow routing methods of watershed models are also subjected by these two main classifications which are known as a lumped flow routing (hydrologic routing; unsteady uniform flow) and distributed flow routing (hydraulic routing; unsteady non-uniform flow) (Chow et al., 1988; Vieux, 2004).

1.3 Research Aim and Objective

The aim of this study is to model rainfall runoff in Bentong catchment using an integrated distributed GIS model combining NRCS CN, kinematic wave approximation and manning's equation. In order to achieve the main objective, the specific objectives as shown below have to be completed:

1. To determine optimum resolution size of DEM towards the distributed model output
2. To develop the distributed GIS rainfall runoff model (SDTT) and spatial lumped model (SLM)
3. To determine the effects of land use changes in 16 years towards rainfall runoff
4. To compare the model output from SDTT model with spatial lumped based model (SLM)

1.4 Research Questions

A few questions required to be answered in this study?

1. Based on GIS technology, is it possible to develop a prototype watershed GIS based model?
2. Can the model developed able to simulate different kind of watershed land use satisfactorily?
3. How sensitive the spatial distributed model towards parameter input manipulation?
4. Does spatial GIS based using a fully distributed approach performed better in rainfall runoff modelling compared to traditional lumped based approach?

1.5 Scope of study

In this study, Digital Elevation Model (DEM) was downloaded freely from website of Shuttle Radar Topography Mission (SRTM) in order to obtain the topographic features for Bentong catchment and also watershed delineation. Recently, study by Khalid et al., (2016) stated that DEM generated from SRTM produce better result of correlation and RMSE compared to DEM generated using ASTER and GMTED2010 with RMSE = 4.714 and $R^2 = 0.912$. This finding used as the basis of using SRTM DEM for modeling purposes. There are several parameters required to model the rainfall runoff such as land use, soil map and hydrologic soil map. In this study, land use map of Bentong catchment in year 2000, 2010 and 2016 were used. Land use map for the year 2000 and 2010, soil map and hydrologic soil map were obtained from Department of Agriculture (DOA) Malaysia. Meanwhile, the land use map for the year 2016 have been obtained by using the Landsat 8 satellite image. The land use map produced by Landsat 8 was validated at the site and supported by topographic map from Department of Survey.

According to Yu et al (2017), when faced with flood issues, a finer time scale is required in dealing with flood forecasting issue as it is realistically capture the changes of flood processes characteristic. The event based analysis was preferred in this study in order to model the flash flood occurrence within Bentong catchment. Therefore, evaporation and ground water effect can be neglected (Sulaiman et al., 2010). The 15 minutes interval of rainfall and discharge data according to specific year that reflect the land use were collected from Department of Irrigation and Drainage (DID) and will be used during the calibration and validation process. To maintain data reliability, only complete rainfall records on selected event will be used. Furthermore, since DID adopts 0.2 mm tipping bucket at their rain gauges station to be considered as one tip, value less that 0.2 mm in 15 minutes (0.2 mm/15 min) (e.g. 0.1 mm in 15 min) will not be considered (DID, 2009). Rainfall or storm events was selected based on specific storm event using the standard procedure of Antecedant Moisture Condition (AMC) suggested by NRCS CN. This will act as the quality control for the rainfall data used in the rainfall runoff analysis. Only rainfall data and events comply with the stated criteria will use as the input for the modeling purposes. No stochastic procedure will be perform to the rainfall data as the main purpose of this study is to apply distributed based method to perform rainfall runoff modeling as previous study also by (Domnita et al., 2010; Giotti et al., 2013) also apply the same procedure.

This study will evaluate two types of rainfall runoff models which are known as distributed GIS based model and spatial lumped model. There are several types of distributed model which are available in rainfall runoff modelling but most of them are designed for continuous based rainfall such as SWAT, TREX and others. These models are also used a lot of parameters and it requires intensive calibration and validation process. In this study, distributed model will be performing using combination of kinematic wave approximation (KWA) and manning's to route the channel and overland flow to the outlet. Both are mathematical models in routing the water flow both in channel and land. The function of Grid Calculator in ArcGIS software will be used to write and run the grid analysis and to run the model. NRCS CN model will be incorporated in the model also using grid calculator function with the purpose to estimate the effective runoff. Since it is a distributed based model, the area and parameters used in the model will be aggregated into grid cell that contain unique value. To develop the hydrograph at the outlet, time area (TA) method was used with isochrones of 15 minutes interval. All of the distributed model will be built using GIS. The distributed based model in this study will be referred as spatial distributed travel time or SDTT.

For the lumped based model (SLM), there are three major components that need to be considered in developing the lumped based model which are known as the estimation of loss volume, transformation of excess rainfall to runoff and channel routing. GIS was used to prepare the parameter input and hydrologic software called HEC-HMS 4.0 and will be used in the calibration and validation process of the model.

The lumped based model and distributed based model also have been used in this study with the purpose to evaluate the comparison of model performance for both models. In order to assess the evaluation of model performance, the statistical parameters such as NSE, PBIAS, POE and correlation coefficient will be used.

1.6 Significance of study

The application of event based rainfall analysis is rarely used in Malaysia as most of the researchers are more prefer to use the continuous based rainfall analysis in their studies. Therefore, in the present study, the actual rainfall intensity value was obtained from interpolation of rainfall station value using IDW and subsequently used as a distributed model input to simulate rainfall runoff which are more precisely represent the real flash flood event. It was reported that the distributed based model was performed well and in some cases, the model performance of distributed based model was performed much better than lumped based model. Unfortunately, based on the literature review, the distributed based model approach in hydrological modeling carried out in Malaysia is still scarce and limited. The previous studies have used various types of distributed model such as SWAT (Abbaspour et al., 2015), GSSHA (Sharif et al, 2017), TOPMODEL (Nourani et al., 2011), CASC2D (Downer et al., 2002) and TREX (Abdullah et al., 2018) which are commonly used more complex parameters and continuous rainfall based as input. The parameterization is very critical and highly required in this study as it used a lot of parameters and input in the distributed based model approach.

This study used a simple method which combining kinematic wave approximation (KWA) with manning's equation to produce a travel time map. Previously, both equations have been used in hydraulic-based study and lumped based model (Pawar et al., 2013). In the previous study, the lumped based model has been using KWA; the capability of KWA equation was not optimized as the parameterization of parameter in the equation often used in single average value for each sub – catchment wide basis. In this study, the improvement is made as the equation of KWA used and applied in grid size. Due to the GIS capability to process a grid based resolution data; they can be used together with spatial analysis to produce hydrographs at the outlet. This study also used the DEM resolution analysis in producing an accurate input for KWA. From the DEM resolution analysis, the longest line within grid size used as the input for distance to ridges or x which required in the KWA equation.

Each model will be applied for different purposes depending on the desired objectives of water resources management and flood management teams to take into account in mitigating this critical environmental issue. Based on the previous studies that have been reviewed and discussed, there are several studies on distributed model approach have been carried out in globally such as US, China, Iran, Germany, Chile and Austria. However, there is no study in distributed model approach found in developing country such as Malaysia. This study will be the pioneer study in Malaysia specifically Bentong catchment by using KWA equation in distributed form. Moreover, due to the high number of ungauged area and limited gauging station in Malaysia, the GIS based hydrologic model using the Time – Area (TA) method have been adopted and applied in Bentong catchment (tropical catchment) as it can be a plan and strategies for the researchers, planners and engineers in managing the development in sustainable way for the future.

REFERENCES

Abdulla, H. A., Minor, E. C., and Hatcher, P. G. (2010). Using two-dimensional correlations of 13C NMR and FTIR to investigate changes in the chemical composition of dissolved organic matter along an estuarine transect. *Environmental science and technology*, *44*(21), 8044-8049.

Abdullah, M. H., Sidi, J., and Aris, A. Z. (2007). Heavy metals (Cd, Cu, Cr, Pb and Zn) in *Meretrix meretrix* Roding, water and sediments from estuaries in Sabah, North Bornea. *International Journal of Environmental and Science Education*, *2*(3), 69-74.

Abele, D., Heise, K., Pörtner, H. O., and Puntarulo, S. (2002). Temperature-dependence of mitochondrial function and production of reactive oxygen species in the intertidal mud clam Mya arenaria. *Journal of Experimental Biology*, *205*(13), 1831-1841.

Abowei, J. F. N. (2010). Salinity, dissolved oxygen, pH and surface water temperature conditions in Nkoro River, Niger Delta, Nigeria. *Adv. J. Food Sci. Technol*, *2*(1), 36-40.

Abril, G., Commarieu, M. V., Sottolichio, A., Bretel, P., and Guerin, F. (2009). Turbidity limits gas exchange in a large macrotidal estuary. *Estuarine, Coastal and Shelf Science*, *83*(3), 342-348.

Afiati, N. (2007). Hermaphroditism in Anadara granosa (L.) and Anadara antiquata (L.)(Bivalvia: Arcidae) from central Java. *Journal of Coastal Development*, *10*(3), 171-179.

Afiati, N. (2013). Gonad maturation of two intertidal blood clams Anadara granosa (L.) and Anadara antiquata (L.)(Bivalvia: Arcidae) in Central Java. *Journal of Coastal Development*, *10*(2), 105-113.

Albentosa, M., Fernández-Reiriz, M. J., Labarta, U., and Pérez-Camacho, A. (2007). Response of two species of clams, Ruditapes decussatus and Venerupis pullastra, to starvation: physiological and biochemical parameters. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*, *146*(2), 241-249.

Anderson, P. G. (1996, May). Sediment generation from forestry operations and associated effects on aquatic ecosystems. In *Proceedings of the Forest-Fish Conference: Land Management Practices Affecting Aquatic Ecosystems* (pp. 491-508).

Andersen, T. J., Lanuru, M., van Bernem, C., Pejrup, M., and Riethmueller, R. (2010). Erodibility of a mixed mudflat dominated by microphytobenthos and Cerastoderma edule, East Frisian Wadden Sea, Germany. *Estuarine, Coastal and Shelf Science*, *87*(2), 197-206.

Anderson, D. M., Glibert, P. M., and Burkholder, J. M. (2002). Harmful algal blooms and eutrophication: nutrient sources, composition, and consequences. *Estuaries*, *25*(4), 704-726.

Angell, C. (1987). Better management through better knowledge: BOBP [Bay of Bengal Programme] cockle activities in Malaysia. *Bay of Bengal News*.

Anzecc, A. (2000). Australian and New Zealand guidelines for fresh and marine water quality. *Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra*, 1-103.

Aquatic, L. (1985). Commercial Cockle Farming in Southern Thailand Sin i Tookwinas Translated from Thai.

Asmus, H., Asmus, R. M., and Reise, K. (1990). Exchange processes in an intertidal mussel bed: A Sylt-flume in the Wadden Sea. *Berichte der Biologischen Anstalt Helgoland. Hamburg*, (6), 79.

Bamber, R. N. (1990). The effects of acidic seawater on three species of lamellibranch mollusc. *Journal of Experimental Marine Biology and Ecology*, *143*(3), 181-191.

Bayne, B. L. (2004). Phenotypic flexibility and physiological tradeoffs in the feeding and growth of marine bivalve molluscs. *Integrative and Comparative Biology*, *44*(6), 425-432.

Bao, Y., Wang, Q., and Lin, Z. (2011). Hemoglobin of the bloody clam *Tegillarca granosa* (Tg-HbI) is involved in the immune response against bacterial infection. *Fish and shellfish immunology*, *31*(4), 517-523.

Bayne, B. (1973). The responses of three species of bivalve mollusc to declining oxygen tension at reduced salinity. *Comparative Biochemistry and Physiology Part A: Physiology*, *45*(3), 793-806.

Bayne, B. L., Iglesias, J. I. P., Hawkins, A. J. S., Navarro, E., Heral, M., and Deslous-Paoli, J. M. (1993). Feeding behaviour of the mussel, Mytilus edulis: responses to variations in quantity and organic content of the seston. *Journal of the Marine Biological Association of the United Kingdom*, *73*(4), 813-829.

Becker, C. D., and Thatcher, T. O. (1973). *Toxicity of power plant chemicals to aquatic life* (Vol. 7). Richland, WA: Battelle Pacific Northwest Laboratories.

Binding, C. E., Bowers, D. G., and Mitchelson-Jacob, E. G. (2005). Estimating suspended sediment concentrations from ocean colour measurements in moderately turbid waters; the impact of variable particle scattering properties. *Remote sensing of Environment*, *94*(3), 373-383.

Björnsäter, B. R., and Wheeler, P. A. (1990). Effect of nitrogen and phosphorus supply on growth and tissue composition of Ulva fenestrata and Enteromorpha intestinalis (Ulvales, Chlorophyta). *Journal of Phycology*, *26*(4), 603-611.

Blanton, J. O., Lin, G., and Elston, S. A. (2002). Tidal current asymmetry in shallow estuaries and tidal creeks. *Continental Shelf Research*, *22*(11-13), 1731-1743.

Boonruang, P., and Janekarn, V. (1983). Distribution, density, biomass and population bionomics of Anadara granosa (L.) in relation to environmental factors at Sapum Bay on the east coast of Phuket Island [Thailand]. *Thai Fisheries Gazette*.

Bragadeeswaran, S., Rajasegar, M., Srinivasan, M., and Rajan, U. K. (2007). Sediment texture and nutrients of Arasalar estuary, Karaikkal, south-east coast of India. *Journal of Environmental Biology*, *28*(2), 237-240.

Brasington, J., and Richards, K. (2000). Turbidity and suspended sediment dynamics in small catchments in the Nepal Middle Hills. *Hydrological processes*, *14*(14), 2559-2574.

Brevik, E. C., and Fenton, T. E. (2002). Influence of soil water content, clay, temperature, and carbonate minerals on electrical conductivity readings taken with an EM-38. *Soil Horizons*, *43*(1), 9-13.

Briggs J C, *Marine Zoogeography*, (McGraw-Hill Co. New York), 1974, pp. 475.

Broom, M.J. 1980. Community and production ecology of Anadara granosa (L.) with particular reference to its gastropod predators. University of Malaya, Kuala Lumpur. 349 Ph.D. thesis.

Broom, M. J. (1982a). Structure and seasonality in a Malaysian mudflat community. *Estuarine, Coastal and Shelf Science*, *15*(2), 135-150.

Broom, M. J. (1982b). Analysis of the Growth of Anadara granosa (Bivalvia: Arcidae) in Natural, Artificially Seeded and Experimental Populations. *Marine ecology progress series. Oldendorf*, *9*(1), 69-79.

Broom, M. J. (Ed.). (1985). *The biology and culture of marine bivalve molluscs of the genus Anadara* (Vol. 12). WorldFish.

Borsuk, M. E., Stow, C. A., Luettich Jr, R. A., Paerl, H. W., and Pinckney, J. L. (2001). Modelling oxygen dynamics in an intermittently stratified estuary: estimation of process rates using field data. *Estuarine, Coastal and Shelf Science*, *52*(1), 33-49.

Bouillon, S., Connolly, R. M., and Lee, S. Y. (2008). Organic matter exchange and cycling in mangrove ecosystems: recent insights from stable isotope studies. *Journal of Sea Research*, *59*(1-2), 44-58.

Burdon, D., Callaway, R., Elliott, M., Smith, T., and Wither, A. (2014). Mass mortalities in bivalve populations: A review of the edible cockle Cerastoderma edule (L.). *Estuarine, Coastal and Shelf Science*, *150*, 271-280.

Burke L, Kura Y, Kassem K, Revenga C, Spalding M and McAllister D, *Pilot Analysis of Global Ecosystems*, (World Resources Institute, Washington DC), 2001, pp. 77.

Butler, A. J. (1983). A preliminary examination of populations of the kai-koso, Anadara cornea (Reeve) near Suva, Fiji. *A report to the Institute of Marine Resources, University of the South Pacific, Suva, Fiji. 28p*.

Buzzelli, C. P., Luettich Jr, R. A., Powers, S. P., Peterson, C. H., McNinch, J. E., Pinckney, J. L., and Paerl, H. W. (2002). Estimating the spatial extent of bottom-water hypoxia and habitat degradation in a shallow estuary. *Marine ecology progress series*, *230*, 103-112.

Cadee, N. (1993). *The Uptake and Release of Material by the Cockle Cerastoderma Edule L. in the Western Scheldt Estuary, SW Netherlands*. National Institute of Coastal and Marine Management.

Calabrese, A., and Davis, H. C. (1966). The pH tolerance of embryos and larvae of Mercenaria mercenaria and Crassostrea virginica. *The Biological Bulletin*, *131*(3), 427-436.

Callaway, R., Grenfell, S., Bertelli, C., Mendzil, A., and Moore, J. (2014). Size, distribution and sediment biodeposition of prolific bivalves in small estuaries. *Estuarine, Coastal and Shelf Science*, *150*, 262-270.

Campbell, G., and S. Wildberger. 1992. The Monitor's Handbook. LaMotte Company, Chestertown, MD. 71 pp.

Cantor T, *Catalogue of Malayan Fishes*, (1849).

Carmichael, R. H., Walton, W., and Clark, H. (2012). Bivalve-enhanced nitrogen removal from coastal estuaries. *Canadian journal of fisheries and aquatic sciences*, *69*(7), 1131-1149.

Cazan, A. M., and Klerks, P. L. (2015). Effects from a short-term exposure to copper or cadmium in gravid females of the liverbearer fish (*Gambusia affinis*). *Ecotoxicology and Environmental Safety*, *118*, 199-203.

Chang, F. J., and Chen, Y. C. (2003). Estuary water-stage forecasting by using radial basis function neural network. *Journal of Hydrology*, *270*(1-2), 158-166.

Chapman, P. M., Wang, F., Adams, W. J., and Green, A. (1999). Appropriate applications of sediment quality values for metals and metalloids. *Enviromenatls Sciene and Technology*, 33, 3937-3941.

Choi, T. S., Kang, E. J., Kim, J. H., and Kim, K. Y. (2010). Effect of salinity on growth and nutrient uptake of Ulva pertusa (Chlorophyta) from an eelgrass bed. *Algae*, *25*(1), 17-26.

Chen, C. C., Gong, G. C., and Shiah, F. K. (2007). Hypoxia in the East China Sea: One of the largest coastal low-oxygen areas in the world. *Marine Environmental Research*, *64*(4), 399-408.

Chen, C. W., Kao, C. M., Chen, C, F., and Dong, C. D. (2007). Distribution and accumulation of heavy metals in the sediments of Kaohsiung Harbor, Taiwan. *Chemosphere, 66,* 1431-1440.

Chen, X., Wo, F., Chen, C., and Fang, K. (2010). Seasonal changes in the concentrations of nitrogen and phosphorus in farmland drainage and groundwater of the Taihu Lake region of China. *Environmental monitoring and assessment*, *169*(1-4), 159-168.

Cherry, D. S., Scheller, J. L., Cooper, N. L., and Bidwell, J. R. (2005). Potential effects of Asian clam (Corbicula fluminea) die-offs on native freshwater mussels (Unionidae) I: water-column ammonia levels and ammonia toxicity. *Journal of the North American Benthological Society*, *24*(2), 369-380.

Chua, T.E. and J.R. Charles. 1984. Coastal Resources of East Coast Peninsular Malaysia. Penerbit Universiti Sains Malaysia. 306 p.

Chua, T. E. 1986. Managing ASEAN coastal resources. Tropical Coastal Area Management, Vol. 1, No. 1 ICLARM, Manila. pp. 8–10.

Chua, T.E. and A.T. White 1988. Policy Recommendations for Coastal Area Management in the ASEAN Region. Contrib. No. 544, ICLARM, Manila. 10 p.

Ciutat, A., Widdows, J., and Readman, J. W. (2006). Influence of cockle Cerastoderma edule bioturbation and tidal-current cycles on resuspension of sediment and polycyclic aromatic hydrocarbons. *Marine Ecology Progress Series*, *328*, 51-64.

Coates, C. J., and Decker, H. (2017). Immunological properties of oxygen-transport proteins: hemoglobin, hemocyanin and hemerythrin. *Cellular and Molecular Life Sciences*, *74*(2), 293-317.

Crawford, C. M., Macleod, C. K., and Mitchell, I. M. (2003). Effects of shellfish farming on the benthic environment. *Aquaculture*, *224*(1-4), 117-140.

Crossland, C. J., Baird, D., Ducrotoy, J. P., Lindeboom, H., Buddemeier, R. W., Dennison, W. C., and Swaney, D. P. (2005). The coastal zone—a domain of global interactions. In *Coastal Fluxes in the Anthropocene* (pp. 1-37). Springer, Berlin, Heidelberg.

Clark, J. R. 1977. Coastal ecosystems management: A technical manual for the conservation of coastal zone resources. Wiley-Interscience, New York. 928p.

Clark, J. R. 1980. Progress in management of coastal ecosystems. Helgolander Meeresunters 33. pp. 721–31.

Clements, J. C., and Hunt, H. L. (2014). Influence of sediment acidification and water flow on sediment acceptance and dispersal of juvenile soft-shell clams (Mya arenaria L.). *Journal of Experimental Marine Biology and Ecology*, *453*, 62-69.

Clements, J. C., Woodard, K. D., and Hunt, H. L. (2016). Porewater acidification alters the burrowing behavior and post-settlement dispersal of juvenile soft-shell clams (Mya arenaria). *Journal of Experimental Marine Biology and Ecology*, *477*, 103-111.

Cognetti, G., and Maltagliati, F. (2000). Biodiversity and adaptive mechanisms in brackish water fauna. *Marine Pollution Bulletin*, *40*(1), 7-14.

Collett, L. C., and O'gower, A. K. (1972). Molluscan hemoglobins with unusual temperature-dependent characteristics. *Comparative Biochemistry and Physiology Part A: Physiology*, *41*(4), 843-850.

Crain, C. M., Silliman, B. R., Bertness, S. L., and Bertness, M. D. (2004). Physical and biotic drivers of plant distribution across estuarine salinity gradients. *Ecology*, *85*(9), 2539-2549.

Cuffney, T. F. (1988). Input, movement and exchange of organic matter within a subtropical coastal black water river-flood plain system. *Freshwater Biology*, *19*(3), 305-320.

Dame, R. F. (1996). Bivalves as components of ecosystem health. *The Ecology of Marine Bivalves. An Ecosystem Approach. CRC Marine Science Series, CRC Press, Boca Raton, FL*, *254*, 213-226.

Dame, R. F. (Ed.). (2013). *Bivalve filter feeders: in estuarine and coastal ecosystem processes* (Vol. 33). Springer Science and Business Media.

Dalman, O., Demirak, A., and Balci, A. (2006). Determination of heavy metals (Cd, Pb) and trace elements (Cu, Zn) in sediments and fish of the Southeastern Aegean Sea (Turkey) by atomic absorption spectrometry. *Food Chem., 95*, 157-162.

Dare, P. J., Bell, M. C., Walker, P., and Bannister, R. C. A. (2004). Historical and current status of cockle and mussel stocks in The Wash. *CEFAS, Lowestoft*, 85.

Daskalakis, K. D., and O'connor, T. P. (1995). Normalization and elemental sediment contamination in the coastal United States. *Environmental Science and Technology*, *29*(2), 470-477.

Davenport, J., and Wong, T. M. (1986). Responses of the blood cockle Anadara granosa (L.)(Bivalvia: Arcidae) to salinity, hypoxia and aerial exposure. *Aquaculture*, *56*(2), 151-162.

Day, J. W., Yáñez-Arancibia, A., Kemp, W. M., and Crump, B. C. (2012). *Introduction to estuarine ecology* (pp. 1-18). John Wiley and Sons, Inc.

Dell'Anno, A., Mei, M. L., Pusceddu, A., and Danovaro, R. (2002). Assessing the trophic state and eutrophication of coastal marine systems: a new approach based on the biochemical composition of sediment organic matter. *Marine Pollution Bulletin*, *44*(7), 611-622.

Deni, S. M., Suhaila, J., Zin, W. Z. W., and Jemain, A. A. (2010). Spatial trends of dry spells over Peninsular Malaysia during monsoon seasons. *Theoretical and Applied Climatology*, *99*(3-4), 357.

DOFM, 2013 Annual Fisheries Statistics Book 2013 Department of Fisheries Malaysia. Putrajaya, pp. 27-41.

De Graaf, G., and Prein, M. (2005). Fitting growth with the von Bertalanffy growth function: a comparison of three approaches of multivariate analysis of fish growth in aquaculture experiments. *Aquaculture Research*, *36*(1), 100-109.

Dube, A., Zbytniewski, R., Kowalkowski, T., Cukrowska, E., and Buszewski, B. (2001). Adsorption and migration of heavy metals in soil. *Polish journal of environmental studies*, *10*(1), 1-10.

Du Laing, G., Rinklebe, J., Vandecasteele, B., Meers, E., and Tack, F. M. (2009). Trace metal behaviour in estuarine and riverine floodplain soils and sediments: a review. *Science of the total environment*, *407*(13), 3972-3985.

Eusterhues, K., Rumpel, C., Kleber, M., and Kögel-Knabner, I. (2003). Stabilisation of soil organic matter by interactions with minerals as revealed by mineral dissolution and oxidative degradation. *Organic Geochemistry*, *34*(12), 1591-1600.

Elghali, S. B., Benbouzid, M. E. H., and Charpentier, J. F. (2007, May). Marine tidal current electric power generation technology: State of the art and current status. In *Electric Machines and Drives Conference, 2007. IEMDC'07. IEEE International* (Vol. 2, pp. 1407-1412). IEEE.

EPA. (2012). pH. In Water: Monitoring and Assessment. Retrieved from http://water.epa.gov/type/rsl/monitoring/vms54.cfm

Evans, C. D., Monteith, D. T., and Cooper, D. M. (2005). Long-term increases in surface water dissolved organic carbon: observations, possible causes and environmental impacts. *Environmental pollution*, *137*(1), 55-71.

Falchuk, K. H., Fawcett, D. W., and Vallee, B. L. (1975). Role of zinc in cell division of Euglena gracilis. *Journal of cell science*, *17*(1), 57-78.

FAO, 2012 The state of world fisheries and aquaculture 2012. Available online at http://www.fao.org dated 20 December, 2013.

Faulkner, P. (2009). Focused, intense and long-term: evidence for granular ark (Anadara granosa) exploitation from late Holocene shell mounds of Blue Mud Bay, northern Australia. *Journal of Archaeological Science*, *36*(3), 821-834.

Fredericks, A. D. (2014). *The secret life of clams: the mysteries and magic of our favorite shellfish*. New York, NY: Skyhorse Publishing.

Gabriel, U. U., Akinrotimi, O. A., and Orlu, E. E. (2011). Haematological characteristics of the Bloody cockle anadara senilis (L.) from Andoni flats, Niger Delta, Nigeria. *Science World Journal*, *6*(1), 1-4.

Gilbert, D., Sundby, B., Gobeil, C., Mucci, A., and Tremblay, G. H. (2005). A seventy-two-year record of diminishing deep-water oxygen in the St. Lawrence estuary: The northwest Atlantic connection. *Limnology and Oceanography*, *50*(5), 1654-1666.

Gosling, E. (2008). *Bivalve molluscs: biology, ecology and culture*. John Wiley and Sons.

Greenberg Arnold, E., and Clesceri Lenore, S. (1992). Standard methods for the examination of water and wastewater.

Green, M. A., Jones, M. E., Boudreau, C. L., Moore, R. L., and Westman, B. A. (2004). Dissolution mortality of juvenile bivalves in coastal marine deposits. *Limnology and Oceanography*, *49*(3), 727-734.

Green, M. A., Waldbusser, G. G., Hubazc, L., Cathcart, E., and Hall, J. (2013). Carbonate mineral saturation state as the recruitment cue for settling bivalves in marine muds. *Estuaries and Coasts*, *36*(1), 18-27.

Green, M. A., Waldbusser, G. G., Reilly, S. L., Emerson, K., and O'Donnell, S. (2009). Death by dissolution: sediment saturation state as a mortality factor for juvenile bivalves. *Limnology and Oceanography*, *54*(4), 1037-1047.

Gubler, C. J., Lahey, M. E., Ashenbrucker, H., Cartwright, G. E., and Wintrobe, M. M. (1952). Studies-on copper metabolism. 1. A method for the determination of copper in whole blood, red blood cells, and plasma. *Journal of Biological Chemistry*, *196*, 209-220.

Harlin, M. M., and Thorne-Miller, B. (1981). Nutrient enrichment of seagrass beds in a Rhode Island coastal lagoon. *Marine Biology*, *65*(3), 221-229.

Hambrick, G. A., DeLaune, R. D., and Patrick, W. H. (1980). Effect of estuarine sediment pH and oxidation-reduction potential on microbial hydrocarbon degradation. *Applied and Environmental Microbiology*, *40*(2), 365-369.

Hargrave, B. T. (1972). Aerobic decomposition of sediment and detritus as a function of particle surface area and organic content. *Limnology and Oceanography*, *17*(4), 583-586.

Harith, H., Husain, M. L., and Akhir, M. F. M. (2016). Coastal oceanographic processes associated with blood cockle (Anadara granosa) induce spawning season in Kapar, Selangor, Malaysia. *Journal of Ocean Engineering and Science*, *1*(4), 289-299.

Harris, J. O., Maguire, G. B., Edwards, S. J., and Hindrum, S. M. (1999). Effect of pH on growth rate, oxygen consumption rate, and histopathology of gill and kidney tissue for juvenile greenlip abalone, Haliotis laevigata Donovan and blacklip abalone, Haliotis rubra Leach. *Journal of Shellfish Research*, *18*(2), 611-619.

Hawkins, A. J. S., Duarte, P., Fang, J. G., Pascoe, P. L., Zhang, J. H., Zhang, X. L., and Zhu, M. Y. (2002). A functional model of responsive suspension-feeding and growth in bivalve shellfish, configured and validated for the scallop Chlamys farreri during culture in China. *Journal of Experimental Marine Biology and Ecology*, *281*(1-2), 13-40.

Hawkins, A. J. S., Smith, R. F. M., Tan, S. H., and Yasin, Z. B. (1998). Suspension-feeding behaviour in tropical bivalve molluscs: Perna viridis, Crassostrea belcheri, Crassostrea iradelei, Saccostrea cucculata and Pinctada margarifera. *Marine Ecology Progress Series*, 173-185.

Horn, H. (2003). The relative importance of climate and nutrients in controlling phytoplankton growth in Saidenbach Reservoir. *Hydrobiologia*, *504*(1-3), 159-166.

Huang, X., Xu, Y., and Karato, S. I. (2005). Water content in the transition zone from electrical conductivity of wadsleyite and ringwoodite. *Nature*, *434*(7034), 746.

Huckle, J. M., Potter, J. A., and Marrs, R. H. (2000). Influence of environmental factors on the growth and interactions between salt marsh plants: effects of salinity, sediment and waterlogging. *Journal of Ecology*, *88*(3), 492-505.

Huebers, H. A. (1991). Iron. In: E. Median (Ed). *Metals and their compounds in the environment: Occurrence, analysis and biological relevance.* Weinhem: VCH.

Hickin, E. J. (Ed.). (1995). River Geomorphology. Chichester: Wiley.

Ikenaga, M., Guevara, R., Dean, A. L., Pisani, C., and Boyer, J. N. (2010). Changes in community structure of sediment bacteria along the Florida coastal everglades marsh–mangrove–seagrass salinity gradient. *Microbial ecology*, *59*(2), 284-295.

Ismail, A., Badri, M. A., and Ramlan, M. N. (1993). The background levels of heavy metal concentration in sediments of the west coast of Peninsular Malaysia. *Science of the total environment*, *134*, 315-323.

Ismail, A., Jusoh, N. R., and Ghani, I. A. (1995). Trace metal concentrations in marine prawns off the Malaysian coast. *Marine Pollution Bulletin*, *31*(1), 108-110.

Ismail, A., and Idris, B. A. G (1996). Lead, zinc and copper content in coastal sediments from the west coast of Peninsular Malaysia. *Malaysian Applied Biology,* 25, 37-39.

Ismail, A., and Ramli, R. (1997). Trace metals in sediments and molluscs from an estuary receiving pig farms effluent. *Environmental Technology*, *18*(5), 509-515.

Izura, S. N., and Hooi, T. K. (2008, July). Shaping the future of cockle industry in Malaysia. In *Proceedings of the National Fisheries Symposium (NAFIS), Kuala Terengganu, Terengganu* (pp. 14-16).

Jalal, K. C. A., Noor Faizul, H. N., Kamaruzzaman, B. Y., Shahbudin, S., Alam, M. Z., Jaswir Irwandi. (2009). Studies on physico-chemical characteristics and sediment environment along the coastal waters in Pulau Tuba, Langkawi, Malaysia. *Aquatic Ecosystem Health and Management, 12,* 350-357.

Jarernpornnipat, A., and Buppha, N. (2012). Effects of environmental factors on condition index of blood cockle (Anadara spp .) in Bandon Bay , Suratthani - Thailand, 22–28.

Jennerjahn, T. C., and Ittekkot, V. (2002). Relevance of mangroves for the production and deposition of organic matter along tropical continental margins. *Naturwissenschaften*, *89*(1), 23-30.

Ji, X., Sheng, J., Tang, L., Liu, D., and Yang, X. (2011). Process study of circulation in the Pearl River Estuary and adjacent coastal waters in the wet season using a triply-nested circulation model. *Ocean Modelling*, *38*(1-2), 138-160.

Jones, J. R., Knowlton, M. F., Obrecht, D. V., and Cook, E. A. (2004). Importance of landscape variables and morphology on nutrients in Missouri reservoirs. *Canadian Journal of Fisheries and Aquatic Sciences*, *61*(8), 1503-1512.

Kasai, A., and Nakata, A. (2005). Utilization of terrestrial organic matter by the bivalve Corbicula japonica estimated from stable isotope analysis. *Fisheries Science*, *71*(1), 151-158.

Kellogg, C. E. (1993). Soil survey division staff: soil survey manual. *United States Department of Agriculture, Washington*.

Kim, J.D. and J.H. Koo. 1973. Studies on the seedling production of the ark, *Anadara broughtoni* (Schrenck) in tank. (1). Bull. Fish. Res. Develop. Agency, Pusan 11: 71-78. Liong, P. C. (1979). Large scale mortality of cockle in Province Wellesley. *Malaysian agricultural journal*.

King, R. S., Hines, A. H., Craige, F. D., and Grap, S. (2005). Regional, watershed and local correlates of blue crab and bivalve abundances in subestuaries of Chesapeake Bay, USA. *Journal of Experimental Marine Biology and Ecology*, *319*(1-2), 101-116.

Kristensen, E. (2000). Organic matter diagenesis at the oxic/anoxic interface in coastal marine sediments, with emphasis on the role of burrowing animals. In *Life at interfaces and under extreme conditions* (pp. 1-24). Springer, Dordrecht.

Lalonde, K., Mucci, A., Ouellet, A., and Gélinas, Y. (2012). Preservation of organic matter in sediments promoted by iron. *Nature*, *483*(7388), 198.

Lawson, S. E., Wiberg, P. L., McGlathery, K. J., and Fugate, D. C. (2007). Wind-driven sediment suspension controls light availability in a shallow coastal lagoon. *Estuaries and Coasts*, *30*(1), 102-112.

Lefeuvre, J. C., Bouchard, V., Feunteun, E., Grare, S., Laffaille, P., and Radureau, A. (2000). European salt marshes diversity and functioning: the case study of the Mont Saint-Michel bay, France. *Wetlands Ecology and Management*, *8*(2-3), 147-161.

Lei, F., and Poulin, R. (2011). Effects of salinity on multiplication and transmission of an intertidal trematode parasite. *Marine Biology*, *158*(5), 995-1003.

Lepori, F., Palm, D., and Malmqvist, B. (2005). Effects of stream restoration on ecosystem functioning: detritus retentiveness and decomposition. *Journal of Applied Ecology*, *42*(2), 228-238.

Li, P., and Gao, X. (2014). Trace elements in major marketed marine bivalves from six northern coastal cities of China: Concentration and risk assessment for human health. *Ecotoxicology and Environmental Safety, 109*, 1-9.

Lien, R. C., and Gregg, M. C. (2001). Observations of turbulence in a tidal beam and across a coastal ridge. *Journal of Geophysical Research: Oceans*, *106*(C3), 4575-4591.

Lim, S. H., Samat, A., and Othman, M. R. (2006). Indeks Kualiti Air Negara (Ikan) Sistem Sungai Labu [National water quality index Sungai Labu system]. *Malaysian Journal of Analytical Sciences*, *10*(1), 7-14.

Li, J. S., Hu, F., and Cheng, J. H. (2007). Distributions of fish eggs and juveniles and relations between surface layer water temperature and salinity of the Yangtze estuary water area in spring [J]. *Marine Sciences*, *4*, 004.

Liong, P. C. (1979). Large scale mortality of cockle in Province Wellesley. *Malaysian agricultural journal*.

Lowe, D. R., and Guy, M. (2000). Slurry-flow deposits in the Britannia Formation (Lower Cretaceous), North Sea: a new perspective on the turbidity current and debris flow problem. *Sedimentology*, *47*(1), 31-70.

Lundquist, C. J., Pilditch, C. A., and Cummings, V. J. (2004). Behaviour controls post-settlement dispersal by the juvenile bivalves Austrovenus stutchburyi and Macomona liliana. *Journal of Experimental Marine Biology and Ecology*, *306*(1), 51-74.

Luoma, S. N., Dagovitz, R., and Axtmann, E. (1990). Temporally intensive study of trace metals in sediments and bivalves from a large river-estuarine system: Suisun Bay/Delta in San Francisco Bay. *Science of the Total Environment*, *97*, 685-712.

MacFarlane, G. R., and Burchett, M. D. (2000). Cellular distribution of copper, lead and zinc in the grey mangrove, *Avicennia marina* (Forsk.) Vierh. *Aquatic Botany, 68*, 45-59.

MacKenzie Jr, C. L. (2005). Removal of sea lettuce, Ulva spp., in estuaries to improve the environments for invertebrates, fish, wading birds, and eelgrass, Zostera marina. *Marine Fisheries Review*, *67*(4), 1-8.

Mao, J. D., Tremblay, L., Gagné, J. P., Kohl, S., Rice, J., and Schmidt-Rohr, K. (2007). Humic acids from particulate organic matter in the Saguenay Fjord and the St. Lawrence Estuary investigated by advanced solid-state NMR. *Geochimica et Cosmochimica Acta*, *71*(22), 5483-5499.

Mao, Q., Shi, P., Yin, K., Gan, J., and Qi, Y. (2004). Tides and tidal currents in the Pearl River Estuary. *Continental Shelf Research*, *24*(16), 1797-1808.

Marfai, M. A., and King, L. (2008). Potential vulnerability implications of coastal inundation due to sea level rise for the coastal zone of Semarang city, Indonesia. *Environmental Geology*, *54*(6), 1235-1245.

Masscheleyn, P. H., Delaune, R. D., and Patrick, W. H. (1991). Arsenic and selenium chemistry as affected by sediment redox potential and pH. *Journal of Environmental Quality*, *20*(3), 522-527.

Massie, F. D. (1998). The uncommon guide to common life of Narragansett Bay. *Providence, Rhode Island: Save the Bay*.

Matoo, O. B., Ivanina, A. V., Ullstad, C., Beniash, E., and Sokolova, I. M. (2013). Interactive effects of elevated temperature and CO2 levels on metabolism and oxidative stress in two common marine bivalves (Crassostrea virginica and Mercenaria mercenaria). *Comparative Biochemistry and Physiology Part A: Molecular and Integrative Physiology*, *164*(4), 545-553.

Mazlan, A. G., Zaidi, C. C., Wan-Lotfi, W. M., and Othman, B. H. R. (2005). On the current status of coastal marine biodiversity in Malaysia.

McCormick, J. H., Broderius, S. J., and Fiandt, J. T. (1984). Toxicity of ammonia to early life stages of the green sunfish Lepomis cyanellus. *Environmental Pollution Series A, Ecological and Biological*, *36*(2), 147-163.

Meakin, S. (1992). *The rio earth summit: summary of the united nations conference on environment and development* (Vol. 317). Library of Parliament, Research Branch.

Mfilinge, P. L., Meziane, T., Bachok, Z., and Tsuchiya, M. (2005). Litter dynamics and particulate organic matter outwelling from a subtropical mangrove in Okinawa Island, South Japan. *Estuarine, Coastal and Shelf Science*, *63*(1-2), 301-313.

Moore, P. G. (1977). Inorganic particulate suspensions in the sea and their effects on marine animals. *Oceanogr Mar Biol Annu Rev*, *15*, 225-363.

Mustapha, A., Aris, A. Z., Juahir, H., Ramli, M. F., and Kura, N. U. (2013). River water quality assessment using environmentric techniques: case study of Jakara River Basin. *Environmental Science and Pollution Research*, *20*(8), 5630-5644.

Muthiah, P., Narasimham, K. A., Gopinathan, C. P., and Sundararajan, D. (1992). Larval rearing, spat production and juvenile growth of the blood clam Anadara granosa. *Journal of the Marine Biological Association of India*, *34*(1and2), 138-143.

Nakamura, Y., and Shinotsuka, Y. (2007). Suspension feeding and growth of ark shell Anadara granosa: comparison with ubiquitous species Scapharca subcrenata. *Fisheries science*, *73*(4), 889-896.

Nanson, R. A., Nanson, G. C., and Huang, H. Q. (2010). The hydraulic geometry of narrow and deep channels; evidence for flow optimisation and controlled peatland growth. *Geomorphology*, *117*(1-2), 143-154.

Narasimham, K. A. (1969). Studies on some aspects of biology and fishery of the cockle, Anadara granosa (Linnaeus), from Kakinada Bay.

Newell, R. I. (2004). Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve molluscs: a review. *Journal of Shellfish research*, *23*(1), 51-62.

Nizzoli, D., Welsh, D. T., Fano, E. A., and Viaroli, P. (2006). Impact of clam and mussel farming on benthic metabolism and nitrogen cycling, with emphasis on nitrate reduction pathways. *Marine Ecology Progress Series*, *315*, 151-165.

Ohno, T., and Bro, R. (2006). Dissolved organic matter characterization using multiway spectral decomposition of fluorescence landscapes. *Soil Science Society of America Journal*, *70*(6), 2028-2037.

Okera, W. (1976). Observations on some population parameters of exploited stocks of Senilia senilis (Arca senilis) in Sierra Leone. *Marine Biology*, *38*(3), 217-229.

Oliver, P. G., and Holmes, A. M. (2006). The Arcoidea (Mollusca: Bivalvia): a review of the current phenetic-based systematics. *Zoological Journal of the Linnean Society*, *148*(3), 237-251.

Ong, E. S., and Din, Z. B. (2001). Cadmium , Copper , and Zinc Toxicity to the Clam , Donax faba C ., and the Blood Cockle , Anadara granosa L . *New York*, (October 1999), 86 –93.

Orlov DS (1992) Soil chemistry. Balkema, Brookfield.

Orton, P. M., and Kineke, G. C. (2001). Comparing calculated and observed vertical suspended-sediment distributions from a Hudson River Estuary turbidity maximum. *Estuarine, Coastal and Shelf Science*, *52*(3), 401-410.

Ouyang, Y. (2012). Estimation of shallow groundwater discharge and nutrient load into a river. *Ecological engineering*, *38*(1), 101-104.

Pahri, S. D. R., Mohamed, A. F., and Samat, A. (2016). Preliminary water quality study in cockle farming area in Malaysia: a case study in Jeram, Selangor. *Aquaculture, Aquarium, Conservation and Legislation-International Journal of the Bioflux Society (AACL Bioflux)*, *9*(2).

Pathansali, D., and Soong, M. K. (1958). Some aspects of cockle (Anadara granosa L.) culture in Malaya. *Proceedings of the Indo-Pacific Fisheries Council*, *8*(2), 26-31.

Pathansali, D. (1963). On the effect of salinity changes on the activity of the cockle, Anadara granosa (L). *L. Malay. Agric. J*, *44*, 18-25.

Pathansali, D. (1966). Notes on the biology of the cockle, Anadara granosa L. *Proceedings of the Indo-Pacific Fisheries Council*, *11*(2), 84-98.

Pawson, M. M. (2004). *The cockle Austrovenus stutchburyi and chlorophyll depletion in a southern New Zealand inlet* (Doctoral dissertation, University of Otago).

Pichevin, L. E., Ganeshram, R. S., Francavilla, S., Arellano-Torres, E., Pedersen, T. F., and Beaufort, L. (2010). Interhemispheric leakage of isotopically heavy nitrate in the eastern tropical Pacific during the last glacial period. *Paleoceanography*, *25*(1).

Pilditch, C. A., and Grant, J. (1999). Effect of temperature fluctuations and food supply on the growth and metabolism of juvenile sea scallops (Placopecten magellanicus). *Marine Biology*, *134*(2), 235-248.

Pleanjai, S., Gheewala, S. H., and Garivait, S. (2007). Environmental evaluation of biodiesel production from palm oil in a life cycle perspective. *Asian J. Energy Environ*, *8*(1), 15-32.

Porter, W. M., Cox, W. J., and Wilson, I. (1980). Soil acidity... is it a problem in Western Australia. *Journal of agriculture, Western Australia.*

Postma, H. (1954). *Hydrography of the Dutch Wadden sea*. Rijksuniversiteit Groningen.

Prins, T. C., and Smaal, A. C. (1990). *Benthic pelagic coupling: the release of inorganic nutrients by an intertidal bed of Mytilus edulis*. DIHO.

Radojević, M., and Bashkin, V. N. (2006). Plant analysis. In *Practical Environmental Analysis* (pp. 363-393).

Ramli, M. F. S. B. (2005). *Impacts of coastal land reclamation on the fisheries of Mukim Lekir, Malaysia* (Doctoral dissertation, University of Hull).

Ramli, M. F. S., Abu Hassan, F. R., and Saadon, M. N. (2013). Declining production of cockles in relation to ammonia concentrations in Sungai Buloh River, Selangor. *J Environ Earth Sci*, *3*(10), 1-5.

Radojevic, M., and Bashkin, V. (2007). *Practical environmental analysis*. Royal society of chemistry.

Reuter, J. H. (1977). Organic matter in estuaries. *Chesapeake Science*, *18*(1), 120-121.

Riba, I., Delvalls, T. Á., Forja, J. M., and Gómez-Parra, A. (2004). The influence of pH and salinity on the toxicity of heavy metals in sediment to the estuarine clam Ruditapes philippinarum. *Environmental toxicology and chemistry*, *23*(5), 1100-1107.

Ringwood, A. H., and Keppler, C. J. (2002). Water quality variation and clam growth: is pH really a non-issue in estuaries? *Estuaries*, *25*(5), 901-907.

Riisgård, H. U., Egede, P. P., and Barreiro Saavedra, I. (2011). Feeding behaviour of the mussel, Mytilus edulis: new observations, with a minireview of current knowledge. *Journal of Marine Biology*, *2011*.

Riisgård, H. U., Kittner, C., and Seerup, D. F. (2003). Regulation of opening state and filtration rate in filter-feeding bivalves (Cardium edule, Mytilus edulis, Mya arenaria) in response to low algal concentration. *Journal of experimental marine biology and ecology*, *284*(1-2), 105-127.

Robinson, M., and Rycroft, D. W. (1999). *The impact of drainage on streamflow* (pp. 753-786). American Society of Agronomy.

Rocker, D., Brinkhoff, T., Grüner, N., Dogs, M., and Simon, M. (2012). Composition of humic acid-degrading estuarine and marine bacterial communities. *FEMS microbiology ecology*, *80*(1), 45-63.

Rodriguez, C. A., Flessa, K. W., and Dettman, D. L. (2001). Effects of upstream diversion of Colorado River water on the estuarine bivalve mollusc Mulinia coloradoensis. *Conservation Biology*, *15*(1), 249-258.

Rodríguez-Romero, A., Jiménez-Tenorio, N., Basallote, M. D., Orte, M. R. D., Blasco, J., and Riba, I. (2014). Predicting the impacts of CO2 leakage from subseabed storage: effects of metal accumulation and toxicity on the model benthic organism Ruditapesphilippinarum. *Environmental science and technology*, *48*(20), 12292-12301.

Sanchez-Salazar, M. E., Griffiths, C. L., and Seed, R. (1987). The effect of size and temperature on the predation of cockles Cerastoderma edule (L.) by the shore crab Carcinus maenas (L.). *Journal of Experimental Marine Biology and Ecology*, *111*(2), 181-193.

Sanford, W. E., and Pope, J. P. (2010). Current challenges using models to forecast seawater intrusion: lessons from the Eastern Shore of Virginia, USA. *Hydrogeology Journal*, *18*(1), 73-93.

Santín, C., Yamashita, Y., Otero, X. L., Alvarez, M. A., and Jaffé, R. (2009). Characterizing humic substances from estuarine soils and sediments by excitation-emission matrix spectroscopy and parallel factor analysis. *Biogeochemistry*, *96*(1-3), 131-147.

Sammut, J., White, I., and Melville, M. D. (1996). Acidification of an estuarine tributary in eastern Australia due to drainage of acid sulfate soils. *Marine and Freshwater Research*, *47*(5), 669-684.

Santín, C., Yamashita, Y., Otero, X. L., Alvarez, M. A., and Jaffé, R. (2009). Characterizing humic substances from estuarine soils and sediments by excitation-emission matrix spectroscopy and parallel factor analysis. *Biogeochemistry*, *96*(1-3), 131-147.

Sardessai, S., and Sundar, D. (2007). Variability of nitrate and phosphate. National Institute of Oceanography, India.

Sasekumar A, Distribution of macrofauna on a Malayan mangrove shore, *J Anim Ecol,*. 43 (1974) 51-69.

Sasekumar A, Chong V C and Leh M U C, Fish and prawn communities in mangrove estuaries and mudflats in Selangor Malaysia, In Alcala A.C. (ed). *Proceedings of the Regional Symposium on Living Resources in Coastal Areas*, (1991) pp. 503-512.

Saulais, M., Bedell, J. P., and Delolme, C. (2011). Cd, Cu and Zn mobility in contaminated sediments from an infiltration basin colonized by wild plants: The case of Phalaris arundinacea and Typha latifolia. *Water Science and Technology*, *64*(1), 255-262.

Sawyer, C. (1965). The Sea Lettuce Problem in Boston Harbor. *Journal (Water Pollution Control Federation), 37*(8), 1122-1133.

Schilling, K. E., and Jacobson, P. (2008). Groundwater nutrient concentrations near an incised midwestern stream: effects of floodplain lithology and land management. *Biogeochemistry*, *87*(2), 199-216.

Shafie, N. A., Aris, A. Z., and Puad, N. H. A. (2012). Influential factors on the levels of cation exchange capacity in sediment at Langat river. *Arabian Journal of Geosciences*, *6*(8), 3049–3058.

Sharpley, A., Jarvie, H. P., Buda, A., May, L., Spears, B., and Kleinman, P. (2013). Phosphorus legacy: overcoming the effects of past management practices to mitigate future water quality impairment. *Journal of Environmental Quality*, *42*(5), 1308-1326.

Shazili, N. A. M., Yunus, K., Ahmad, A. S., Abdullah, N., and Rashid, M. K. A. (2006). Heavy metal pollution status in the Malaysian aquatic environment. *Aquatic Ecosystem Health and Management*, *9*(2), 137-145.

Shindo, H. (1991). Elementary composition, humus composition, and decomposition in soil of charred grassland plants. *Soil Science and Plant Nutrition*, *37*(4), 651-657.

Simeonov, V., Stratis, J. A., Samara, C., Zachariadis, G., Voutsa, D., Anthemidis, A. and Kouimtzis, T. (2003). Assessment of the surface water quality in Northern Greece. *Water research*, *37*(17), 4119-4124.Simpson, A. J., Simpson, M. J., Smith, E., and Kelleher, B. P. (2007). Microbially derived inputs to soil organic matter: are current estimates too low?. *Environmental Science and Technology*, *41*(23), 8070-8076.

Singh, K. P., Malik, A., Mohan, D., and Sinha, S. (2004). Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India)—a case study. *Water research*, *38*(18), 3980-3992.

Singh, K. P., Malik, A., and Sinha, S. (2005). Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniques—a case study. *Analytica Chimica Acta*, *538*(1), 355-374.

Slomp, C. P., and Van Cappellen, P. (2004). Nutrient inputs to the coastal ocean through submarine groundwater discharge: controls and potential impact. *Journal of Hydrology*, *295*(1-4), 64-86.

Smaal, A. C., Schellekens, T., van Stralen, M. R., and Kromkamp, J. C. (2013). Decrease of the carrying capacity of the Oosterschelde estuary (SW Delta, NL) for bivalve filter feeders due to overgrazing?. *Aquaculture*, *404*, 28-34.

Sobral, P., and Widdows, J. (2000). Effects of increasing current velocity, turbidity and particle-size selection on the feeding activity and scope for growth of Ruditapes decussatus from Ria Formosa, southern Portugal. *Journal of Experimental Marine Biology and Ecology*, *245*(1), 111-125.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. Accessed on 5/15/2017.

Suwanjarat, J. (1999). Ultrastructure of the spermatogenesis of the cockle Anadara granosa L.(Bivalvia: Arcidae). *Helgoland Marine Research*, *53*(2), 85-91.

Spykerman, N. (2016, May 17). Cockle Trade Threatened. *The Stars Online*. Retrieved from https://www.thestar.com.my/news/nation/2016/05/17/cockle-trade-threatened-production-down-to-16000-tonnes-from-100000-tonnes/.

Squires, H. J., Carlson, B., Ritchie, T. P., and Gundermann, N. (1973). Shellfish on nearshore fishing grounds at Wailoaloa Beach, Nadi, 1973. *Fiji Agricultural Journal*, *35*, 71-74.

Stumpf, R. P. (1983). The process of sedimentation on the surface of a salt marsh. *Estuarine, Coastal and Shelf Science*, *17*(5), 495-508.

Tanyaros, S., and Tongnunui, P. (2011). Influence of environmental variables on the abundance of estuarine clam Meretrix casta (Chemnitz, 1782) in Trang Province, Southern Thailand, *33*(1), 107–115.

Tarnowska, K., Wolowicz, M., Chenuil, A., and Feral, J. P. (2009). Comparative studies on the morphometry and physiology of European populations of the lagoon specialist Cerastoderma glaucum (Bivalvia). *Oceanologia*, *51*(3), 437-458.

Thrush, S. F., Hewitt, J. E., Cummings, V. J., Green, M. O., Funnell, G. A., and Wilkinson, M. R. 2000. The generality of field experiments: Interaction between local and broad-scale processes. Ecology 18:399 - 415.

Thurman, H. V., and Burton, E. A. (1997). *Introductory oceanography*. New Jersey: Prentice Hall.

Todd, M. J., Vellidis, G., Lowrance, R. R., and Pringle, C. M. (2009). High sediment oxygen demand within an instream swamp in southern Georgia: Implications for low dissolved oxygen levels in coastal blackwater streams. *JAWRA Journal of the American Water Resources Association*, *45*(6), 1493-1507.

Tookwinas, S., Peters, H. M., Chonchuenchob, P., Chalayondeja, K., Mutarasint, K., Brouard, F.and Rivaton, J. (2002). Commercial cockle farming in southern Thailand. *Language*, *12817*(12818).

Toyo, T., Tesuji, I., and Inoue, N. (1978). The mass culture of the ark—Anadara and their problems in Yamaguchi Prefecture. *Cult. Res*, *7*, 51-66.

Trujillo, A. P., and Thurman, H. V. (2005). *Essentials of oceanography*. USA: Pearson Prentice Hall; ISBN 0-13-144773-4.

Ubukata, T. (2003). A theoretical morphologic analysis of bivalve ligaments. *Paleobiology*, *29*(3), 369-380.

Uncles, R. J., Stephens, J. A., and Smith, R. E. (2002). The dependence of estuarine turbidity on tidal intrusion length, tidal range and residence time. *Continental Shelf Research*, *22*(11-13), 1835-1856.

United States Environmental Protection Agency. EnviroAtlas. www.epa.gov/enviroatlas. Wastewater and Water Treament. Retrieved: 6/17/2017.

U.S. Geological Survey (USGS). 1999. The Quality of Our Nation's Waters-Nutrients and Pesticides. USGS Circular 1225. 82 pp.

U.S. Environmental Protection Agency (USEPA). 1998. Condition of the Mid-Atlantic Estuaries. EPA 600-R-98-147. November. Office of Research and Development, Washington, DC. 50 pp.

Verween, A., Vincx, M., and Degraer, S. (2007). The effect of temperature and salinity on the survival of Mytilopsis leucophaeata larvae (Mollusca, Bivalvia): The search for environmental limits. *Journal of Experimental Marine Biology and Ecology*, *348*(1-2), 111-120.

Vega, M., Pardo, R., Barrado, E., and Debán, L. (1998). Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis. *Water research*, *32*(12), 3581-3592.

Verwey, J. (1954). On the ecology of distribution of cockle and mussel in the Dutch Waddensea, their role in sedimentation and the source of their food supply. *Archives Neerlandaises de Zoologie*, *10*(2), 171-239.

Wajsbrot, N., Gasith, A., Krom, M. D., and Popper, D. M. (1991). Acute toxicity of ammonia to juvenile gilthead seabream Sparus aurata under reduced oxygen levels. *Aquaculture*, *92*, 277-288.

Walker, N. D., and Hammack, A. B. (2000). Impacts of winter storms on circulation and sediment transport: Atchafalaya-Vermilion Bay region, Louisiana, USA. *Journal of Coastal Research*, 996-1010.

Wan, E. C. K., and Mohamat-Yusuff, F. (2014). Contamination of Trace Elements (Cu, Pb, Cr) in Kong Ko Laut, Johor, Malaysia. In *From Sources to Solution* (pp. 567-572). Springer, Singapore.

Wedepohl, K. H. (1971). Environmental influences on the chemical composition of shales and clays. *Physics and Chemistry of the Earth*, *8*, 307-333.

Weston, D.P. 1990. Quantitative examination of macrobenthic community changes along an organic enrichment gradient. Mar. Ecol. Prog. Ser. 61:233-244.

Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems (3rd ed.). San Diego, CA: Academic Press

Widdicombe, S., Spicer, J. I., and Kitidis, V. (2011). Effects of ocean acidification on sediment fauna. *Ocean acidification. Oxford University Press, Oxford*, 176-191.

Wilber, D. H., and Clarke, D. G. (2001). Biological effects of suspended sediments: a review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. *North American Journal of Fisheries Management*, *21*(4), 855-875.

Wood, A. K. H., Ahmad, Z., Shazili, N. A. M., Yaakob, R., and Carpenter, R. O. Y. (1997). Geochemistry of sediments in Johor Strait between Malaysia and Singapore. *Continental Shelf Research*, *17*(10), 1207-1228.

World Health Organization. (2003). pH in Drinking-water. In Guidelines for drinking-water quality. Retrieved: 6/17/2017.

Yap, C. K., Ismail, A., Tan, S. G., and Omar, H. (2002). Concentrations of Cu and Pb in the offshore and intertidal sediments of the west coast of Peninsular Malaysia. *Environment International*, *28*(6), 467-479.

Yap, C. K., Ismail, A., and Tan, S. G. (2003). Cd and Zn concentrations in the straits of Malacca and intertidal sediments of the west coast of Peninsular Malaysia. *Marine Pollution Bulletin*, *46*(10), 1349-1353.

Yassin, Z. (2006). Environmental Destruction Cause of Decline in Cockle Production. Retrieved from https://www.consumer.org.my/index.php/ development/environment/1012-environmental-destruction-cause-of-decline-in-cockle-production

Yates, M. G., Goss-Custard, J. D., McGrorty, S., Lakhani, K. H., Durell, S. L. V. D., Clarke, R. T., and Frost, A. J. (1993). Sediment characteristics, invertebrate densities and shorebird densities on the inner banks of the Wash. *Journal of Applied Ecology*, 599-614.

Yin, K., Lin, Z., and Ke, Z. (2004). Temporal and spatial distribution of dissolved oxygen in the Pearl River Estuary and adjacent coastal waters. *Continental Shelf Research*, *24*(16), 1935-1948.

Yurimoto, T., Kassim, F. M., Fuseya, R., and Man, A. (2014a). Mass mortality event of the blood cockle, Anadara granosa, in aquaculture ground along Selangor coast, Peninsular Malaysia. *International Aquatic Research*, *6*(4), 177-186.

Yurimoto, T., Kassim, F. M., Man, A., and Fuseya, R. (2014b). Spawning season and larval occurrence of blood cockle (Anadara granosa) off the Selangor coast, Peninsular Malaysia. *International Journal of Aquatic Biology*, *2*(6), 299-304.

Zheng, L., Chen, C., and Liu, H. (2003). A modeling study of the Satilla River Estuary, Georgia. I: Flooding-drying process and water exchange over the salt marsh-estuary-shelf complex. *Estuaries*, *26*(3), 651-669

Zhou, A., Tang, H., and Wang, D. (2005). Phosphorus adsorption on natural sediments: modeling and effects of pH and sediment composition. *Water Research*, *39*(7), 1245-1254.

Zhou, Y., Yang, H., Liu, S., Yuan, X., Mao, Y., Liu, Yuan, X., Mao, Y.,and Zhang, F. (2006). Feeding and grow Abbaspour, K. C., Rouholahnejad, E., Vaghefi, S., Srinivasan, R., Yang, H., & Kløve, B. (2015). A continental-scale hydrology and water quality model for Europe: Calibration and uncertainty of a high-resolution large-scale SWAT model. Journal of Hydrology, 524, 733-752.

Abdullah, J., Muhammad, N. S., Julien, P. Y., Ariffin, J., & Shafie, A. (2018). Flood flow simulations and return period calculation for the Kota Tinggi watershed, Malaysia. Journal of Flood Risk Management, 11, S766-S782.

Adnan, N.A. (2010). Quantifying the impacts of climate and land use changes on the hydrological response of a monsoonal catchment. *P.hd Dissertation*, University of Southampton.

Ahern, M., Kovats, R. S., Wilkinson, P., Few, R., & Matthies, F. (2005). Global health impacts of floods: epidemiologic evidence. *Epidemiologic Reviews*, 27(1), 36-46.

Ajmal, M. & Kim, T.-W. (2015). Quantifying excess storm water using SCS-CN-based rainfall runoff models and different curve number determination methods. *Journal of Irrigation and Drainage Engineering*, 141(3):04014058. doi.org/10.1061/(ASCE)IR.1943- 4774.0000805

Ajmal, M., Khan, T. A., & Kim, T. W. (2016). A CN-based ensembled hydrological model for enhanced watershed runoff prediction. *Water (Switzerland)*: *8*(1), 1–17. doi:org/10.3390/w8010020

Ajami N.K., Gupta, H., Wagener, T. & Sorooshian, S. (2004). Calibration of a semi-distributed hydrologic model for streamflow estimation along a river system. *Journal of Hydrology,* 298:1(4):112–135

Ajami, N.K., Duan, Q., Gao, X. & Sorooshian, S. (2006). Multimodel Combination Techniques for Analysis of Hydrological Simulations: Application to Distributed Model Intercomparison Project Results. *Journal of Hydrometeorology,* **7**: 755–768. doi: 10.1175/JHM519.1.

Ajward, M.H. (1996). A Spatially Distributed Unit Hydrograph Model Using a Geographical Information System. *Ph.D. Dissertation*, University of Calgary, Calgary.

Akbari, A., Samah., A.A., & Raryabor, F. (2016). Raster-based derivation of a flood runoff susceptibility map using the revised runoff curve number (CN) for the Kuantan watershed, Malaysia. *Environmental Earth Sciences,* 75:1379. doi:10.1007/s12665-016-6186-0.

Akbari, S., & Singh, R. (2012). Hydrological modelling of catchments using MIKE SHE. IEEE-International Conference on Advances in Engineering, Science and Management, 335–340.

Al-Khafaji, M. S. & Al-Sweiti, F. H. (2017). Integrated impact of digital elevation model and land cover resolutions on simulated runoff by SWAT model. *Hydrol. Earth Syst. Sci. Discuss.*, https://doi.org/10.5194/hess-2017-653

Al-Mamun, A., Ibrahim, Z.R., & Mat, M.M. Sustainable Flood Protection Plans for Bentong Town, Malaysia. Twelfth International Water Technology Conference, IWTC 12 2008 Alexandria, Egypt.

Al-Smadi, M. (1998). Incorporating spatial and temporal variation of watershed response in a Gisbased hydrologic model. *MS thesis*. Faculty of the Virginia Polytechnic Institute and State University, Blacksburg.

Alexakis, D.D., Grillakis, M.G., Koutroulis, A.G., Agapiou, A., Themistocleous, K., Tsanis, I. K., Michaelides, S., Pashiardis, S., Demetriou, C., Aristeidou, K., Retalis, A., Tymvios, F., & Hadjimitsis, D. G. (2014). GIS and remote sensing techniques for the assessment of land use change impact on flood hydrology: the case study of Yialias basin in Cyprus. *Natural Hazards and Earth System Sciences (NHESS)*, 14:413-426. doi:10.5194/nhess-14-413-2014, 2014.

Altaf, F., Meraj G. & Romshoo S.A. (2013). Morphometric analysis to infer hydrological behaviour of Lidder watershed, Western Himalaya. *Journal of the Geological Society of India*, Article ID (178021), 14 pages.

Ames, D., Rafn, E., Van Kirk, R. & Crosby, B. (2009). Estimation of stream channel geometry in Idaho using GIS-derived watershed characteristics. *Environmental Modelling & Software*, 24(3):444–448. Doi:10.1016/j.envsoft.2008.08.008.

Awasthi, K.D., Sitaula, B.K., Singht, B.R. & Bajacharaya, R.M. (2002). Land use change in two Nepalese watersheds: *GIS and geomorphometric analysis*. Land Degredation & Development, Wiley Publishing.

Andrews, R.G. (1954).The use of relative infiltration indices in computing runoff". Rainfall-runoff relationship, V. P. Singh, ed., *Water Resources Publications*, Littleton, Colo, 1954.Publications, Littleton, Colo, 1954.

Arsiso, B. K., Tsidu, G. M., Stoffberg, G. H., & Tadesse, T. (2017). Climate change and population growth impacts on surface water supply and demand of Addis Ababa, Ethiopia. Climate Risk Management, 18, 21-33. http://dx.doi.org/10.1016/j.crm.2017.08.004.

Azizian, A & Shokoohi, A. (2014). DEM resolution and stream delineation threshold effects on the results of geomorphologic-based rainfall runoff models. *Turkish Journal of Engineering and Environmental Sciences*, 38: 64 – 78. doi:10.3906/muh-1401-13

Baltas, E. A., Dervos, N. A. & Mimikou, M. A. (2007). Research on the initial abstraction ? storage ratio and its effect on hydrograph simulation at a watershed in Greece. *Hydrology and Earth System Sciences Discussions*, European Geosciences Union, 4 (4): 2169-2204.

Barasa, B. N., & Perera, E. D. P. (2018). Analysis of land use change impacts on flash flood occurrences in the Sosiani River basin Kenya. *International Journal of River Basin Management*, 1-10.

Bates, P.D. & De Roo, A.P.J. (2000). A simple raster-based model for flood inundation simulation. *Journal of Hydrology*. 236: 54–77.

Bedient, P.B. and Huber W.C. (1992). Hydrology and Floodplain Analysis (2nd ed), Addison-Wesley, Reading, MA.

Berz, G., Kron, W., Loster, T., Rauch, E., Schimetschek, J., Schmieder, J., ... & Wirtz, A. (2001). World map of natural hazards–a global view of the distribution and intensity of significant exposures. Natural hazards, 23(2), 443-465.

Beven, K., Warren, R., & Zaoui, J. (1980). SHE: Towards a methodology for physically-based distributed forecasting in hydrology. Hydrological Forecasting, The Oxford Symposium, IAHS-AISH, 133–137.

Bishop, M. P., Shroder, J. F., Bonk, R., & Olsenholler, J. (2002). Geomorphic change in high mountains: a western Himalayan perspective. *Global and Planetary change*, *32*(4), 311-329.

Blöschl, G. (2006). Rainfall-Runoff Modeling of Ungauged Catchments. *Encyclopedia of Hydrological Sciences*. 11:133. doi: 10.1002/0470848944.hsa140

Brasington, J. & Richards, K. (1998) . Interactions between model predictions, parameters and DTM scales for TOPMODEL. *Computers and Geosciences*, 24(4): 299-314.

Brooks, K.N., Ffolliot, P.F., Gregersen, H.M. & Thames, J.L. (1991). *Hydrology and the Management of Watersheds*. Ames, IA: Iowa State University Press, 402 pp.

Brown, A.E., Zhang, L., McMahon, T.A., Western, A.W. & Vertessy, R.A. (2005). A review of paired catchment studies for determining changes in water yield resulting from alterations in vegetation. *Journal of Hydrology*, 310: 28–61

Bodoque, J. M., Amérigo, M., Díez-Herrero, A., García, J. A., Cortés, B., Ballesteros-Cánovas, J. A., & Olcina, J. (2016). Improvement of resilience of urban areas by integrating social perception in flash-flood risk management. *Journal of Hydrology*, *541*, 665-676.

Bosch, J.M. & Hewlett, J.D. (1982). A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration, *Journal of Hydrology*, 55: 3–23.

Boughton, W.C. (2004). The Australian water balance model. *Environmental Modelling and Software*, 19:943-956.

Bout, B. & Jetten, V. G. (2018). The validity of flow approximations when simulating catchment – integrated flash floods. *Journal of Hydrology*, 556: 674 – 688.

Brirhet, H. (2016). Comparison of two hydrological models (lumped and distributed) over a pilot area of the Issen watershed in the Souss Basin, Morocco. *European Scientific Journal*, 2(18): 347-357. doi: 10.19044/esj.2016.v12n18p347.

Brooks, K.N, Ffolliot, P.F., Gregersen, H.M. & Thames, J.L. (1991). Hydrology and the Management of Watersheds. Ames, IA: Iowa State University Press, 402 pp

Buchanan, B., Zachary M. E., Schneider, R. &Walter, M.T. (2011). Incorporating Variable Source Area Hydrology Into a Spatially Distributed Direct Runoff Model. *Journal of the American Water Resources Association* (JAWRA), 48(1): 43-60. doi: 10.1111/j.1752-1688.2011.00594.x

Burnash, R.J.C., Ferral, R.L. & McGuire, R.A. (1973). A generalized streamflow generation system- Conceptual modelling for digital computers. Joint Federal and State River Forecast Centre, Sacramento, Technical Report, 204pp.

Burrough, P.A. & R.A. McDonnell (1998). Principles of Geographical Information Systems. Oxford: Oxford University Press.

Carpenter T.M. & Georgakakos K.P. (2006). Intercomparison of lumped versus distributed hydrologic model ensemble simulations on operational forecast scales. *Journal of Hydrology*, 329; 1(2): 174-185. doi:10.1016/j.jhydrol.2006.02.013.

Chalkias, C., Stathopoulus, N., Kalogeropoulos, K. And Karymbalis, E. (2016). Chapter 4: *Applied Hydrological Modeling with the Use of Geoinformatics*: Theory and Practicedoi: http:dx.doi.org/10.5772/62824

Chang, C.-W. (2009). Application of SCS CN Method in HEC-HMS in ShihMen Watershed - Simulation of Rainfall-Runoff Hydrologic Model. *Electronic Theses, Treatises and Dissertations*. Retrieved from http://diginole.lib.fsu.edu/cgi/viewcontent.cgi?article=2143&context=etd

Chase, K.J., Haj, A.E., Regan, R.S. & Viger, R.J. (2016).Potential effects of climate change on streamflow for seven watersheds in eastern and central Montana. *Journal of Hydrology: Regional Studies,* 7(9): 69-81. doi.org/10.1016/j.ejrh.2016.06.001.

Chen, F.W. & Liu, C.W. (2012). Estimation of the spatial rainfall distribution using inverse distance weighting (IDW) in the middle of Taiwan. *Paddy and Water Environment*, 10(3): 209-22.

Chen, H., Xiang, T., Zhou, X. & Xu, C.Y. (2012). Impacts of climate change on the Qingjiang Watershed's runoff change trend in China. *Stochastic Environmental Research and Risk Assessment*, 26: 847. doi:10.1007/s00477-011-0524-2

Chen, S. M., Wang, Y. M., & Tsou, I. (2013). Using artificial neural network approach for modelling rainfall–runoff due to typhoon. *Journal of Earth System Science*, 122:399–405. Doi:org/10.1007/s12040-013-0289-8.

Chiew, F.H.S., Peel, M.C. & Western A.W. (2002). *Application and testing of the simple rainfall-runoff model SIMHYD*. In: Singh, V.P. and Frevert, D.K., (eds.), Mathematical Models of Small Watershed Hydrology and Applications. Water Resources Publications, Litteton, USA, pp. 335-367.

Chinh, L. V., Iseri, H., Hiramatsu, K. & Harada, M. (2010). A GIS - based distributed parameter model for rainfall runoff calculation using Arc Hydro tool and curve number method for Chikugo river basin in Japan. *J. Fac. Agr., Kyushu Univ*, 55(2): 313 – 319.

Chorley, R.J. (1969). Introduction to physical hydrology. Methuen and Co., Ltd., Suffolk 211

Chow, V.T. (1964). Handbook of applied hydrology. McGraw-Hill. New York. Library of Congress Card No. 63-13931

Chow, V.T., Maidment, D.R. & Mays, L.W. (1988). Applied Hydrology. McGraw-Hill Inc., New York, New York.

Clark, C. O., 1945. Storage and the unit hydrograph. *Transactions of the American Society of Civil Engineers,* 110; 2261: 1419-1446.

Coates, L. (1999). Flood fatalities in Australia, 1788-1996. *Australian Geographer, 30*(3), 391-408.

Costa-Cabral, M.C. & Burges, S.J. 1994. Digital Elevation Model Networks (DEMON): A Model of Flow Over Hillslopes for Computation of Contributing and Dispersal Areas. *Water Resources Research*, 30(6), pp: 1681- 1692.

Costa, M. H., Botta, A., & Cardille, J. A. (2003). Effects of large-scale changes in land cover on the discharge of the Tocantins River, Southeastern Amazonia. *Journal of Hydrology, 283*, 206–217.

Costache, R. (2014). Using gis techniques for assessing lag time and concentration time in small river basins. Case study: Pecineaga river basin, Romania. Geographia Technica, 9:1:31 -38

Croke, B.F.W., Andrews, F., Jakeman, A.J., Cuddy, S.M. & Luddy, A. (2006). IHACRES Classic Plus: A re-design of IHACRES rainfall-runoff model. *Environmental Modelling and Software*, 21:426-427.

Croke, B.F.W., Merritt, W.S. & Jakeman, A.J. (2004). A dynamic model for predicting hydrologic response to land cover changes in gauged and ungauged catchments. *Journal of Hydrology*, 291; 1(2): 115-131. doi.org/10.1016/j.jhydrol.2003.12.012.

Daniel, E.B, Camp, J.V, LeBoeuf, E.J., Penrod, J.R., Dobbins, J.P. and Abkowitz, M.D. (2011) Watershed Modelling and its Applications: A State-of-the-Art Review. *The Open Hydrology Journal*. 5:26-50.

Dar, RA., Chandra, R. & Romshoo, S.A. (2013). Morphotectonic and lithostratigraphic analysis of Intermontane Karewa basin of Kashmir Himalayas India. *Journal of Mountain Science*, 10(1):1–15.

Das, T., Bardossy, A. & Zehe, E. (2006). Influence of spatial variability of precipitation in a distributed rainfall-runoff model. Predictions in Ungauged Basins: Promise and Progress (Proceeding of symposium S7, Seventh IAHS Scientific Assembly at Foz do Iguacu, Brazil, April 2005). IAHS Publ. 303.

Deilami, B. R., Al-Saffar, M. R. A., Sheikhi, A., Bala, M. I., & Arsal, D. (2013). Comparison of surface flows derived from different resolution DEM. *Int J Eng Technol IJET-IJENS*, *13*, 82-85.

Deshmukh, A., & Singh, R. (2016). Physio- climatic controls on vulnerability of watersheds to climate and land use change across the United States. *Water Resources Research*.

DeVantier, B. A., & Feldman, A. D. (1993). Review of GIS applications in hydrologic modeling. *Journal of Water Resources Planning and Management*, *119*(2), 246-261.

Dervos, N. A., Baltas, E. A., & Mimikou, M. A. (2006). Rainfall–runoff simulation in an experimental basin using GIS methods. *Journal of Environmental Hydrology*, 14, 1-14.

Dile, Y. T., Karlberg, L., Srinivasan, R. & Rockström, J. (2016). Investigation of the curve number method for surface runoff estimation in tropical regions. *Journal of the American Water Resources Association*, 52(5): 1155 – 1169. doi: 10.1111/1752-1688.12446

Douglas, D.H. (1986). Experiments to locate ridges and channels to create a new type of digital elevation model. *Cartographica*, 23:29–61.

Douinot, A., Roux, H., Pierre-André Garambois, P.-A., Larnier, K., Labat, D. & Dartus, D. (2016). Accounting for rainfall systematic spatial variability in flash flood forecasting. *Journal of Hydrology*, 541; Part A: 359-370. doi:10.1016/j.jhydrol.2015.08.024.

Downer, C. W., Ogden, F. L., Martin, W. D., & Harmon, R. S. (2002). Theory, development, and applicability of the surface water hydrologic model CASC2D. Hydrological processes, 16(2), 255-275.

Dwarakish, G.S., Ganasri, B.P. & Stefano, D.L. (2015) Impact of land use change on hydrological systems: A review of current modeling approaches. *Cogent Geoscience*, 1: 1. Doi:org/10.1080/23312041.2015.1115691

Du, J., Xie, H., Hu, Y., Xu, Y. & Xu, CY. (2009). Development and testing of a new storm runoff routing approach based on time variant spatially distributed travel time method. *Journal of Hydrology*, 389:44-54.

Ebrahimian, M., Nuruddin, a. a. B., Amin, M., Soom, B. M., Sood, a. M., & Neng, L. J. (2012). Runoff Estimation in Steep Slope Watershed with Standard and Slope-Adjusted Curve Number Methods. *Polish Journal of Environmental Studies*, *21*(5): 1191–1202.

Eckhardt, K. (2005). How to construct recursive digital filters for baseflow separation. *Hydrological Processes*, 19(2): 507-15.

El – Shafie, A., Jaafer, O. & Seyed, A. (2011). Adaptive neuro-fuzzy inference system based model for rainfall forecasting in Klang River, Malaysia. *International Journal of the Physical Sciences*, 6(12), pp. 2875-2888. doi: 10.5897/IJPS11.515

Engman, E. T. (1986). Roughness coefficients for routing surface runoff. *Journal of Irrigation and Drainage Engineering ASCE*, 112(1): 39-53.

ESRI: *Arc hydro tools overview.* ESRI, United States of America; 2004.

Fairfield J, & Leymarie P. (1991). Drainage networks from grid digital elevation models. *Water Resour Res* 1991,**27**(5):709–717. Doi: 10.1029/90WR02658

Fatichi, S., Vivoni, E. R., Odgen, F. L., Ivanov, V. Y., Mirus, B., Gochis, D., Downer, C. W., Camporese, M., Davison, J. H., Ebel, B., Jones, N., Kim, J., Mascaro, G., Niswonger, R., Restrepo, P., Rigon, R., Shen, C., Sulis, M. & Tarboton, D. (2016). An overview of current applications, challenges, and future trends in distributed process-based models in hydrology. *Journal of Hydrology*, 537: 45 – 60. https://doi.org/10.1016/j.jhydrol.2016.03.026

Feng-Wen Chen • Chen-Wuing Liu (2012) Estimation of the spatial rainfall distribution using inverse distance weighting (IDW) in the middle of Taiwan. Paddy Water Environ (2012) 10:209–222. DOI 10.1007/s10333-012-0319-1

Fenicia, F., Kavetski, D., Savenije, H. H. G. & Pfister, L. (2016). From spatially variable streamflow to distributed hydrological models: Analysis of key modeling decisions. Water Resources Research, 52, 954–989, doi:10.1002/2015WR017398.

Feyen, L., Vázquez, R., Christiaens, K., Sels, O., & Feyen, J. (2000). Application of a distributed physically-based hydrological model to a medium size catchment. *Hydrology and Earth System Sciences*, 4:47–63. Doi:org/10.5194/hess-4-47-2000

Fohrer, N., Haverkamp, S., Eckhardt, K. & Frede, H.G. (2001). Hydrologic response to land-use changes on the catchment scale. *Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmosphere*, 26 (7): 577-582.

Follum, M. (2015). *Automated Method to Develop a Clark Synthetic Unit Hydrograph within ArcGIS* (No. ERDC/CHL-CHETN-IV-104). ENGINEER RESEARCH AND DEVELOPMENT CENTER VICKSBURG MS COASTAL AND HYDRAULICS LAB.

Gad, M. A. (2013). A useful automated rainfall-runoff model for engineering applications in semi-arid regions. *Computers & geosciences, 52*, 443-452.

Garbrecht, J., Ogden, F. L., DeBarry, P. A., & Maidment, D. R. (2001). GIS and distributed watershed models. I: Data coverages and sources. *Journal of Hydrologic Engineering*, *6*(6), 506-514.

Gebre, T., Kibru, T., Tesfaye, S., & Taye, G. (2015). Analysis of Watershed Attributes for Water Resources Management Using GIS: The Case of Chelekot Micro-Watershed, Tigray, Ethiopia. *Journal of Geographic Information System*, *7*(02), 177.

Ghani, M. W., Arshad, M., Shabbir, A., Shakoor, A., Mehmood, N., & Ahmad, I. (2013). Investigation of Potential Water Harvesting Sites at Potohar Using Modeling Appoach. Pakistan Journal of Agricultural Science, 50(4), 723-729.

Ghavidelfar, S., Alvankar, S.R. & Razmkhah, A. (2011). Comparison of the Lumped and Quasi-distributed Clark Runoff Models in Simulating Flood Hydrographs on a Semi-arid Watershed. *Water Resources Management*, 25: 1775. doi:10.1007/s11269-011-9774-5

Gibbs, M.S., Dandy, G.C. & Maier, H.R. (2010). Evaluation of parameter setting for two GIS based unit hydrograph models. *Journal of Hydrology*, 393; 3(4), 8: 197-205. doi.org/10.1016/j.jhydrol.2010.08.014.

Gigović, L., Pamučar, D., Bajić, Z., & Drobnjak, S. (2017). Application of GIS-interval rough AHP methodology for flood hazard mapping in urban areas. *Water*, *9*(6), 360.

Golmohammadi, G., Prasher, S., Madani, A. & Rudra, R. (2014). Evaluating three hydrological distributed watershed models: MIKE-SHE, APEX, SWAT. *Hydrology*, 1: 20 – 39, doi: 10.3390/hydrology1010020

Gonzalez, A., Temimi, M. & Khanbilvardi, R. (2015). Adjustment to the curve number (NRCS – CN) to account for the vegetation effect on hydrological processes. Hydrological Sciences Journal, 60 (4): 591 – 605, doi: 10.1080/02626667.2014.898119

Gosain, A.K., Mani, A. & Dwivedi, C. (2009). Hydrological Modelling-Literature Review. Climawater, Report NO.1.

Gosain, A.K. and Mani, A. (2009). Hydrological Modelling-Literature Review, Report No. 1, Indo-Norwegian Institutional Cooperation Program, 2009-2011.

Grayson, R. B., Moore, I. D., & McMahon, T. A. (1992). Physically based hydrologic modeling: Is the concept realistic? *Water Resources Research*, 26:2659–2666. Doi:org/10.1029/92WR01259

Gravelius, H. (1914). Grundrifi der gesamten Gewcisserkunde. Band I: Flufikunde (Compendium of Hydrology, vol. I. Rivers, in German). Goschen, Berlin, Germany.

Gumindoga, W., Rientjes, T., Shekede, M. D., Rwasoka, D. T., Nhapi, I., & Haile, A. T. (2014). Hydrological impacts of urbanization of two catchments in Harare, Zimbabwe. *Remote Sensing*, *6*(12), 12544-12574.

Gupta, A. (1988). Large floods as geomorphic events in the humid tropics. In Flood Geomorphology, Baker VR, Kochel RC, Patton PC (eds). Wiley: New York; 301–315.

Gupta, H. V., Sorooshian, S., & Yapo, P. O. (1999). Status of automatic calibration for hydrologic models: Comparison with multilevel expert calibration. *Journal of Hydrologic Engineering*, *4*(2), 135-143.

Haddeland, I., Matheussen, B. V., & Lettenmaier, D. P. (2002). Influence of spatial resolution on simulated streamflow in a macroscale hydrologic model. *Water Resources Research*, *38*(7).

Halff, A. M., Halff, H. M., & Azmoodeh, M. (1993). Predicting runoff from rainfall using neural network. In *Engineering hydrology* (pp. 760–765). New York, NY: American Society of Civil Engineers.

Haile, A.T. (2005). Integrating hydrodynamic model and high resolution of DEM (LiDAR) for flood modelling. *M.Sc. Dissertation*. The International Institute for Geo-Information Science and Earth Observation (ITC), Netherlands.

Hajat, S., Ebi, K. L., Kovats, S., Menne, B., Edwards, S., & Haines, A. (2003). The human health consequences of flooding in Europe and the implications for public health: a review of the evidence. *Applied Environmental Science and Public Health, 1*, 13-21.

Halwatura, D. & Najim, M., 2013. Application of the HEC-HMS model for runoff simulation in a tropical catchment. *Environmental Modelling & Software*, 46: 155-162.

Hawkins, R.H., Ward, T.J., Woodward, D.E. & van Mullem, J.A. (eds). (2009). *Curve Number Hydrology:* State of the 5 Practice; ASCE: Reston, VAKhare, D., Patra, D., Mondal, A. et al. Applied Water Science, 7: 787. doi:10.1007/s13201-015-0292-0

HEC, 2008. HEC-HMS, User's Manual Version 3.3. Hydrologic Engineering Center California.

Hewlett, J.D. & Hibbert, A.R. (1967). Factors affecting the response of small watersheds to precipitation in humid areas. In Sopper, W.E. and Lull, H.W., editors, Forest hydrology, New York: Pergamon Press, 275-90. *Progress in Physical Geography*, 33(2):288-293.

Heywood, I., Cornelius, S. & Carver, S. (2006). An introduction to Geographical Information Systems, Harlow, Pearson Education.

Hibbert, A. R. (1965). *Forest treatment effects on water yield*. Coweeta Hydrologic Laboratory, Southeastern Forest Experiment Station.

Hoblit, B.C. & Curtis, D. C. (2001). Integrating Radar Rainfall Estimates with Digital Elevation Models and Land use Data to create an Accurate Hydrological Model. Presented at the Flood Plain Management Association Spring 2001 Conference. San Diego, California, March 13-16.

Horritt, M.S. & Bates, P.D. (2001). Effect of Spatial Resolution on a Raster Based Model of Flood Flow. *Journal of Hydrology*, **253**:239-249.

Horton R.E. (1932). Drainage basin characteristics. *Transactions of the American Geophysical Union*, 13: 350–361.

Horton R.E. (1945). Erosional development of streams and their drainage basins; hydrological approach to quantitative morphology. *Geological Society of America Bulletin*, 56, pp 275– 370.

Huang, M., Gallichand, J., Wang, Z. and Goulet, M. (2005), A modification to the Soil Conservation Service curve number method for steep slopes in the Loess Plateau of China. Hydrol. Process., 20: 579–589. doi:10.1002/hyp.5925

Hublart, P., Ruelland, D., de Cortázar-Atauri, I. G., Gascoin, S., Lhermitte, S. & Ibacache, A. (2016). Reliability of lumped hydrological modeling in a semi-arid mountainous catchment facing water-use changes. *Hydrol. Earth Syst. Sci*., 20: 3691–3717, doi: 10.5194/hess-20-3691-2016

Hudson, P.F. & Colditz, R.R. (2003). Flood delineation in a large and complex alluvial valley, lower Pánuco basin, Mexico. *Journal of Hydrology*, 280: 229–245.

Huo, Z., Feng, S., Kang, S., Li, W. & Chen, S. (2008), Effect of climate changes and water-related human activities on annual stream flows of the Shiyang river basin in arid north-west China. *Hydrological Processes*, 22: 3155–3167. doi:10.1002/hyp.6900

Iseri, H., Hiramatsu, K., Harada, M., & Mori, M. (2013). Simulation of rainfall runoff and pollutant load for Chikugo River basin in Japan using a GIS-based distributed parameter model. *Paddy and Water Environment*, *11*(1-4), 97-112.

Jain, M. K., Mishra, S. K. & Singh, V.P. (2006). Evaluation of AMC Dependent SCS-CN-Based Models Using Watershed Characteristics. *Water Resources Management*, 20: 531–552,

Jajarmizadeh, M., Harun, S. & Salarpour, M. (2012). A Review on Theoretical Consideration and Types of Models in Hydrology. *Journal of Environmental Science and Technology, 5: 249-261.*

Jenson, S. (1991). Applications of hydrologic information automatically extracted from digital elevation models. *Hydrological Processes*, 5(1):31–44. Doi:10.1002/hyp.3360050104

Jenson, S.K. & Domingue, J.O. 1988. Extracting topographic structure from Digital Elevation Data for Geographic Information System analysis. *Photogrammetric Engineering and Remote Sensing*, 54(11), pp: 1593- 1600.

Jiang, T., Chen, Y.D., Xu, C.-y., Chen, X., Chen, X. & Singh, V.P. (2007). Comparison of hydrological impacts of climate change simulated by six hydrological models in the Dongjiang Basin, South China. *Journal of Hydrology,* 336: 3(4):316-333. doi.org/10.1016/j.jhydrol.2007.01.010.

Jonkman, S. N. (2005). Global perspectives on loss of human life caused by floods. *Natural hazards*, *34*(2), 151-175.

Jonkman, S. N., & Kelman, I. (2005). An analysis of the causes and circumstances of flood disaster deaths. *Disasters*, *29*(1), 75-97.

Jonkman, S. N., & Vrijling, J. K. (2008). Loss of life due to floods. *Journal of flood risk management*, *1*(1), 43-56.

Jonsdottir, H., Madsen, H., & Palsson, O. P. (2006). Parameter estimation in stochastic rainfall-runoff models. *Journal of Hydrology*, 326:(1-4):379-393.

Kale, V.S. & Gupta, A. (2001). Introduction to geomorphology. Academic (India) Publishers, New Delhi.

Kalogeropoulos, K., Karalis, S., Karymbalis, E., Chalkias, C., Chalkias, G., & Katsafados, P. (2013). Modeling flash floods in vouraikos river mouth. In Proceedings of the MEDCOAST conference (pp. 1135-1146).

Kalyanapu, A. J., Burian, S. J. & McPherson, T. N. (2009). Effect of land use-based surface roughness on hydrologic model output. *Journal of Spatial Hydrology*, 9 (2): 51 – 71.

Kamaruddin, M.K.A. (2014). Analisis Perubahan Pelan Sungai Dan Bentuk Geometrik Dasar Sungai Pahang, Malaysia. *P.hD Dissertation*. Universiti Kebangsaan Maaysia. *In Malay*.

Kang, K. & Merwade, V. (2011). Development and application of a storage–release based distributed hydrologic model using GIS. *Journal of Hydrology*, 403: 1–13, doi: 10.1016/j.jhydrol.2011.03.048.

Karalis, S., Karymbalis, E., Valkanou, K., Chalkias, C., Katsafados, P., Kalogeropoulos, K., ... & Bofilios, A. (2014). Assessment of the relationships among catchments' morphometric parameters and hydrologic indices. *International Journal of Geosciences*, *5*(13), 1571.

Kazakis, N., Kougias, I., & Patsialis, T. (2015). Assessment of flood hazard areas at a regional scale using an index-based approach and Analytical Hierarchy Process: Application in Rhodope–Evros region, Greece. *Science of the Total Environment*, *538*, 555-563.

Khare, D., Patra, D., Mondal, A., & Kundu, S. (2017). Impact of landuse/land cover change on run-off in the catchment of a hydro power project. *Applied Water Science*, *7*(2), 787-800.

Khadka, D., Babel, M.S., Shrestha, S. & Tripathi, N.K. (2014). Climate change impact on glacier and snow melt and runoff in Tamakoshi basin in the Hindu Kush Himalayan (HKH) region. *Journal of Hydrology,* 511: 49-60. doi.org/10.1016/j.jhydrol.2014.01.005.

Khalid, N. F., Din, A. H. M., Omar, K. M., Khanan, M. F. A., Omar, A. H., Hamid, A. I. A., & Pa'suya, M. F. (2016). Open-Source Digital Elevation Model (DEMs) Evaluation With GPS and LiDAR Data. *International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences*, *42*.

Khan, K. N. (2002). *A Geographic Information System Based Spatially Distributed Rainfall-Runoff Model* (Doctoral dissertation, University of Pittsburgh)..

Kilgore JL (1997) Developent and evauation of a GIS-based spatially distributed unit hydrograph model. Dissertation, Faculty of Virginia Polytechnic Institute, State University.

Kolios, S., Vorobev, A. V., Vorobeva, G. R., & Stylios, C. (2017). Geographic Information Systems. In *GIS and Environmental Monitoring* (pp. 3-45). Springer International Publishing.

Konadu, D. & Fosu, C. (2009). Digital Elevation Models and GIS for Watershed Modelling and Flood Prediction -A Case Study of Accra Ghana. In *Appropriate Technologies for Environmental Protection in the Developing World*. Springer; 2009:325–332.

Krajewski, W. F., Lakshmi, V., Georgakakos, K. P. & Jain, S. C. (1991). A Monte Carlo study of rainfall sampling effect on a distributed catchment model. *Water Resources Research,* 27(1): 119–128.

Kuntiyawichai, K., Sri-Amporn, W., & Plermkamon, V. (2014). Development process for integrated water resources management plan under a bottom-up participation perspective. *Engineering and Applied Science Research*, *41*(2), 163-171.

Lacroix, M., Martz, L., Kite, G. & Garbrecht, J. (2002). Using digital terrain analysis modelling techniques for the parameterization of a hydrologic model. *Environmental Modelling & Software*, 17(2):125–134. Doi:10.1016/S1364-8152(01)00042-1

Lei, X., Wang, Y., Liao, W., Jiang, Y., Tian, Y., & Wang, H. (2011). Development of efficient and cost-effective distributed hydrological modeling tool MWEasyDHM based on open-source MapWindow GIS. *Computers & Geosciences*, *37*(9), 1476-1489.

Liang, X., Guo, J. & Leung L.R. (2004). Assessment of the effects of spatial resolutions on daily water flux simulations. *Journal of Hydrology*, 298: 287–310.

Lighthill, M. J. & Whitham, G. B. (1955). "On Kinematic Waves. I. Flood Movement in Long Rivers". *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 229 (1178): 281.

Lim, K. J., Engel, B. A., Tang, Z., Choi, J., Kim, K.-S., Muthukrishnan, S. and Tripathy, D. (2005). Automated web GIS based hydrograph analysis tool, WHAT[1]. *JAWRA Journal of the American Water Resources Association,* 41: 1407–1416. doi:10.1111/j.1752-1688.2005.tb03808.x

Lin, W.T., Chou, W.C., Lin, C.Y., Huang, P.H. & Tsai, J.S. (2008). WinBasin: using improved algorithms and the GIS technique for automated watershed modelling analysis from digital elevation models. *International Journal of Geographical Information Science,.* 22(1/2):47–69.

Liu, Z. & Todini, E. (2002). Towards a comprehensive physically based rainfall-runoff model. Hydrology and Earth System Sciences, 6(5): 859–881. doi:10.5194/hess-6-859-2002, 2002.

Liu, Z. & Todini, E. (2005), Assessing the TOPKAPI non-linear reservoir cascade approximation by means of a characteristic lines solution. Hydrological Processes, 19: 1983–2006.

Lopes, V. L. (1996). On the effect of uncertainty in spatial distribution of rainfall on catchment modelling. *Catena*, 28: 107–119.

Luo, W. & Harlin, J. M. (2003). A theoretical travel time based on watershed hypsometry. *JAWRA Journal of the American Water Resources Association*, 39: 785–792. doi:10.1111/j.1752-1688.2003.tb04405.x

Maidment D.R. (2002). ArcHydro, GIS for Water Resources, ESRI Press, Redlands, California.

Maidment D.R. (2004). Arc Hydro Data Model: A Hydrologic Data Integration Tool, Center for Research in Water Resources, GIS Applications in Hydrology, Vol. 3, No. 3, University of Texas, pp. 18-19.

Martin, P. H., LeBoeuf, E. J., Dobbins, J. P., Daniel, E. B., & Abkowitz, M. D. (2005). Interfacing GIS with water resource models: A state-of-the-art review. *Journal American Water Resources Association*. 41(6), 1471-1487.

Martin, T. G., Wintle, B. A., Rhodes, J. R., Kuhnert, P. M., Field, S. A., Low- Choy, S. J., ... & Possingham, H. P. (2005). Zero tolerance ecology: improving ecological inference by modelling the source of zero observations. *Ecology letters*, *8*(11), 1235-1246.

Martz, L.W. & Garbrecht, J. (1992). Numerical definition of drainage network and subcatchment areas from digital elevation models. *Computers & Geosciences.* 18 (6), 747 – 761.

Martz, L. W. & Garbrecht, J. (1993). Automated extraction of drainage network and watershed data from digital elevation models[1]. *JAWRA Journal of the American Water Resources Association*, 29: 901–908. doi:10.1111/j.1752-1688.1993.tb03250.x

Matheussen, B., Kirschbaum, R.L., Goodman, I.A., O'Donnell, G.M & Lettenmaier, D.P. (2000). Effects of land cover change on streamflow in the interior Columbia river basin (U. S. A. and Canada). *Hydrological Processes*, 14: 867–885.

McCuen, R.H 1989. Hydrologic Analysis and Design. Prentice Hall. 867pp

Meenu, R., Rehana, S. and Mujumdar, P. P. (2013), Assessment of hydrologic impacts of climate change in Tunga–Bhadra river basin, India with HEC-HMS and SDSM. Hydrol. Process., 27: 1572–1589. doi:10.1002/hyp.9220

Melesse A.M., Graham W.D. & Jordan J.D. (2003). Spatially distributed watershed mapping and modeling. GIS based storm runoff response and hydrograph analysis, *Part 2. Journal of Spatial Hydrology*, 3(2):1–28

Melesse, M.A. & Graham, W.D. (2004). Storm runoff prediction based on a spatially distributed travel time method utilizing remote sensing and GIS. *Journal of The American Water Resources Association (JAWRA)*, 40 (4): 863-879.

Meenu, R., Rehana, S., & Mujumdar, P. P. (2013). Assessment of hydrologic impacts of climate change in Tunga–Bhadra river basin, India with HEC- HMS and SDSM. *Hydrological Processes*, *27*(11), 1572-1589.

Melsen, L., Teuling, A., Torfs, P., Zappa, M., Mizukami, N., Clark, M. & Uijlenhoet, R. (2016). Representation of spatial and temporal variability in large-domain hydrological models: case study for a mesoscale pre-Alpine basin. *Hydrol. Earth Syst. Sci*., 20, 2207–2226, doi:10.5194/hess-20-2207-2016

Meraj, G., Romshoo, S.A., Yousuf, A.R. & Altaf, F. (2015). Assessing the influence of watershed characteristics on the flood vulnerability of Jhelum basin in Kashmir Himalaya. *Natural Hazard*, 77: 153. doi:10.1007/s11069-015-1605-1.

Mesa, L.M. (2006). Morphometric analysis of a subtropical Andean basin (Tucuman, Argentina). *Environmental Geology*, 50:1235–1242.

Meselhe E.A., Habib E.H., Oche O.C. & Gautam, S. (2009). Sensitivity of conceptual and physically based hydrologic models to temporal and spatial rainfall sampling. *Journal of Hydrologic Engineering*, 14:7:711 doi:10.1061/(ASCE)1084-0699(2009)14:7(711)

Michel, C., Andreassian, V. & Perrin, C. (2005). Soil Conservation Service Curve Number method: How to mend a wrong soil moisture accounting procedure? *Water Resources Research*, 41:W02011. doi: 10.1029/2004WR003191.

Miller V.C, (1953), A quantitative geomorphic study of drainage basin characteristics in the Clinch mountain area. Technical Report-3 Columbia. University Department of Geology New York.

Mishra, S. K., Jain, M. K., Pandey, R. P., & Singh, V. P. (2005). Catchment area-based evaluation of the AMC-dependent SCS-CN inspired rainfall-runoff models. *Hydrological Processes*, 19 (14): 2701–2718

Mishra, S. K., Jain, M. K., & Singh, V. P. (2004). Evaluation of the SCS-CN based model incorporating antecedent moisture. *Journal of Water Resource Management*, 18, 567–589.

Mishra S.K., Sahu R.K., Eldho T.I. & Jain M.K. (2006). An improved *Ia-S* relation incorporating antecedent moisture in 19 SCS-CN methodology. *Water Resources Management,* 20: 643-660

Mishra S. K., & Singh V. P. (2004). Long-term hydrological simulation based on the Soil Conservation Service curve number. *Hydrological Processes*, 18: 1291–1313.

Mockus, V. (1949). Estimation of total (peak rates of) surface runoff for individual storms", Exhibit A of Appendix B, Interim Survey Rep. Grand (Neosho) River Watershed, USDA, Washington, D.C., 1949.

Montgomery, D.R. & Dietrich, W.E. (1989) Source areas, drainage density, and channel initiation. *Water Resources Research*, 25; 8: 1907–1918.

Montgomery, D.R. & Dietrich, W.E. (1992). Channel initiation and the problem of landscape scale. *Science*, 255; 5046: 826–830.

Moore, I. D., Grayson, R. B., & Ladson, A. R. (1991). Digital terrain modelling: a review of hydrological, geomorphological, and biological applications. *Hydrological Processes, 5*(1); 3-30.

Moriasi, D. N., Arnold, J. G., Van Liew, M. W., Bingner, R. L.,Harmel, R. D., & Veith, T. L. 2007. Model evaluation guidelines for systematic quantification of accuracy in watershed simulations.Trans. Asabe,50(3), 885-900

MSMA.(2010). Department of Irrigation and Drainage (DID). Urban Stormwater Management Manual for Malaysia. 2nd Edition. Government of Malaysia.

Mulligan, M. (2004). *Modelling catchment hydrology*. In Mulligan, M., Wainwright, J., eds., Environmental Modelling. London : Wiley, 2004. 432 pp. ISBN 0-471-49617-0

Murphy, P., Ogilvie, J., Meng, F. & Arp, P. (2007). Stream network modelling using lidar and photogrammetric digital elevation models: a comparison and field verification. *Hydrological Processes,* 22(12):1747–1754.

Mutua, B.M. & Klik, A. (2007). Predicting daily streamflow in ungauged rural catchments: the case of Masinga catchment, Kenya, Hydrological Sciences Journal, 52:2:292-304. doi: 10.1623/hysj.52.2.292

Muzik, I. (1996). Flood Modeling With GIS-Derived Distributed Unit Hydrographs. *Hydrological Processes,* **10**(10):1401-1409.

Nag, S.K. (1998). Morphometric analysis using remote sensing techniques in the Chaka subwatershed, Purulia district, West Bengal. *Journal of the Indian Society of Remote Sensing*, 26(1&2):69–76.

Nag, S.K. & Chakraborthy, S. (2003). Influence of rock types and structures in the development of drainage network in hard rock area. *Journal of the Indian Society of Remote Sensing*, 31(1):2535.

National Research Council (US). Committee on Methodologies for Predicting Mudflow Areas, & United States. Federal Emergency Management Agency. (1982). *Selecting a methodology for delineating mudslide hazard areas for the National Flood Insurance Program*. National Academies.

Nikola Zlatanović & Sonja Gavrić. (2013). Comparison Of An Automated And Manual Method For Calculating Storm Runoff Response In Ungauged Catchments In Serbia. *Journal of Hydrology and Hydromechanics,* 61(3): 195–201.

Niehoff, D., Fritsch, U., & Bronstert, A. (2002). Land-use impacts on storm-runoff generation: scenarios of land-use change and simulation of hydrological response in a meso-scale catchment in SW-Germany. *Journal of Hydrology*, 267: 80–93. doi.org/10.1016/S0022-1694(02)00142-7

Niel, H., Paturel, J. E., & Servat, E. (2003). Study of parameter stability of a lumped hydrologic model in a context of climatic variability. *Journal of Hydrology*, 278: 213–230. Doi:org/10.1016/S0022-1694(03)00158-6.

NRCS (2002). National Engineering Handbook: Part 630 Hydrology. USDA, Washington, D.C.

Noorbakhsh, M. E., Rahnama, M. B., & Montazeri, S. (2005). Estimation of instantaneous unit hydrograph with Clark's method using GIS techniques. Journal of Applied Sciences(Pakistan), 5(3), 455-458.

Noto, L. V., & La Loggia, G. (2007). Derivation of a distributed unit hydrograph integrating GIS and remote sensing. *Journal of Hydrologic Engineering*, *12*(6), 639-650.

Nourani, V., Roughani, A., & Gebremichael, M. (2011). TOPMODEL capability for rainfall-runoff modeling of the Ammameh watershed at different time scales using different terrain algorithms. Journal of Urban and Environmental Engineering, 5(1), 1-14.

Obled, C. H., Wendling, J. & Beven, K. (1994) The sensitivity of hydrological models to spatial rainfall patterns: an evaluation using observed data. *Journal of Hydrology*, 159: 305–333.

O'Callaghan J. F. & Mark, D. M. (1984). The extraction of drainage networks from digital elevation data. *Computer Vision, Graphics, and Image Processing*, 28:323–344.

Olang, L. O. and Fürst, J. (2011), Effects of land cover change on flood peak discharges and runoff volumes: model estimates for the Nyando River Basin, Kenya. *Hydrological Processes*, 25: 80–89. doi:10.1002/hyp.7821

Olivera, F. & Maidment, D.R. (1999). Geographic Information Systems (GIS)-based spatially distributed model for runoff routing. *Water Resources Research*, 35(4):1155–1164. doi:10.1029/1998WR900104.

Oliveira, P. T. S., Nearing, M. A., Hawkins, R. H., Stone, J. J., Rodrigues, D. B. B., Panachuki, E. & Wendland, E. (2016). Curve number estimation from Brazilian Cerrado rainfall and runoff data. Journal of Soil and Water Conservation, 71(5): 420 – 429, doi: 10.2489/jswc.71.5.420

Pack, R. T., Tarboton, D. G., & Goodwin, C. N. (2001). Assessing Terrain Stability in a GIS using SINMAP, *15th annual GIS conference, GIS 2001*. Vancouver, British Columbia.

Palamuleni, L. G., Ndomba, P. M., & Annegarn, H. J. (2011). Evaluating land cover change and its impact on hydrological regime in Upper Shire river catchment, Malawi. *Regional Environmental Change*, *11*(4), 845-855.

Pan, F. F., Peters-Lidard, C. D., Sale, M. J., & King, A. W. (2004). A comparison of geographical information systems-based algorithms for computing the TOPMODEL topographic index. *Water Resources Research*, 40(6): W06303. [doi:10.1029/2004WR003069]

Panahi, A., Alijani, B., Mohammadi, H. (2010). The effects of land use/cover changes on the floods of the Madarsu Basin of Northeastern Iran. *Journal of Water Resource and Protection (JWARP),* 2:373-379. Doi:10.4236/jwarp.2010.24043.

Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., & Hanson, C. E. (2007). IPCC, 2007: climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change.

Paudel M., Nelson E.J. & Scharffenberg, W. (2009). Comparison of lumped and quasi-distributed Clark runoff models using the SCS curve number equation. *Journal of Hydrological Engineering,* 14:1098–1106

Pawar, D. B., Kumar, P., & Kyada, P. (2013). Rainfall runoff modeling using fuzzy technique for a small watershed in Maharashtra, India. *Int. J. Eng. Manage. Sci*, *4*, 388-394.

Pechlivanidis, I.G., Jackson, B.M., Mcintyre, N.R., Wheater, H.S., 2011. Catchment scale hydrological modeling: A review of model types, calibration approaches and uncertainty analysis methods in the context of recent developments in technology and applications. Global Nest J.13(3), 193-214

Pérez-Sánchez, J., Senent-Aparicio, J., Segura-Méndez, F. & David Pulido-Velazquez, D. (2017). Assessment of lumped hydrological balance models in peninsular Spain. *Hydrol. Earth Syst. Sci. Discuss*., https://doi.org/10.5194/hess-2017-424

Perrin, C., Michel, C. & Andreassian, V. (2003). Improvement of a parsiminous model for streamflow simulation. *Journal of Hydrology* , 279: 275-289.

Phetprayoon, T. (2015). Application of GIS-based Curve Number Method for Runoff Estimation in Agricultural-Forest Watershed , Thailand, *20*(2):155–167.

Pike, A. S., Scatena, F. N., & Wohl, E. E. (2016). Lithologicaland fluvial controls on the geomorphology of tropical montane stream channels in Puerto Rico. Earth Surface Processes and Landforms, 35(12), 1402–1417. http://doi.org/10.1002/esp.1978

Plesca, I., Timbe, E., Exbrayat, J.F., Windhorst, D., Kraft, P., Crespo, P., Vaché, K.B., Frede, H.G., Breuer, L. (2012). Model intercomparison to explore catchment functioning: Results from a remote montane tropical rainforest. *Ecological Modelling*, 239: 3-13. doi:10.1016/j.ecolmodel.2011.05.005.

Ponce, V.M. & Hawkins, R.H. (1996). 'Runoff curve number: Has it reached maturity?', *Journal of Hydrologic Engineering, ASCE*, 1 (1) : 11-19.

Quinn, P., Beven, K. J., Chevalier, P., & Planchon, O. (1991). The prediction of hillslope flow paths for distributed hydrological modelling using digital terrain models. *Hydrological Processes*, 5(1): 59-79. doi:10.1002/hyp.3360050106.

Rallison, R.E. & Miller, N. (1982). 'Past, present, and future,' Proc., Int. Symp. Rainfall-Runoff Relationship, (ed. V.P. Singh), Water Resources Pub., P.O. Box 2841, Littleton, Colorado 80161.

Ramshoo, S. A., Bhat, S. A. & Rashid, I. (2012). Geoinformatics for Assessing the Morphometric Control on Hydrological Response at Watershed Scale in the Upper Indus Basin. *Journal of Earth System Science*, 121(3): 659-686.

Rawls, W., Brakensieki, D. & Miller, N. (1983). "Predicting Green and Ampt Infiltration Parameters from Soils Data". *ASCE Journal of Hydraulic Engineering*, 109:62–70. 39,91, 99

Razavi, S., Tolson, B. A., Matott, L. S., Thomson, N. R., MacLean, A., & Seglenieks, F. R. (2010). Reducing the computational cost of automatic calibration through model preemption. *Water Resources Research*, *46*(11).

Re, M. (2007). Natural catastrophes 2006: Analyses, assessments. *Positions. Munich Re Publications, Munich*.

Reed S., Koren V., Smith M., Zhang Z., Moreda F., Seo D.J., & DMIP Participants. (2004). Overall distributed model intercomparison project results. *Journal of Hydrology*, 298:1(4): 27-60. doi:10.1016/j.jhydrol.2004.03.031.

Refsgaard, J. C. (1997). Parameterisation, calibration and validation of distributed hydrological models. *Journal of Hydrology*, *198*(1), 69-97.

Reggiani, P., Todini, E. & Meißner, D. (2014). Analytical solution of a kinematic wave approximation for channel routing. *Hydrology Research*, 45 (1): 43 57. doi**:** 10.2166/nh.2013.157.

Ren, L., Wang, M., Li, C., & Zhang, W. (2002). Impacts of human activities on river runoff in the northern area of China. *Journal of Hydrology*, 261: 204–217

Reza, K. (2014). Simulation of Runoff using Modified SCS-CN Method using GIS System, Case Study: Klang Watershed in Malaysia. *Research Journal of Environmental Sciences, 8: 178-192.*

Ritter, D.F., Kochel, R.C. & Miller, I.R. (2002), Process Geomorphology. McGraw Hill, Boston.

Ross, B.B., Contractor, D.N. & Shanholtz, V.O. (1979). Finite element model of overland and channel flow for assessing the hydrologic impact of land-use change. Journal of Hydrology, 41 (1–2): 11–30.

Saghafian, B., Julien, P.Y. & Rajaie, H. (2002). Runoff hydrograph simulation based on time variable isochrones technique. *Journal of Hydrology*, 261: 193-203.

Saghafian, B., Farazjoo, H., Bozorgy, B. et al. (2008). Water Resource Management 22: 1051. https://doi.org/10.1007/s11269-007-9210-z

Sahu, N., Obi Reddy, G. P., Kumar, N., Nagaraju, M. S. S., Srivastava, R. & Singh, S. K. (2017). Morphometric analysis in basaltic terrain of central India using GIS techniques: a case study. Applied Water Science, 7 (5): 2493 - 2499, https://doi.org/10.1007/s13201-016-0442-z

Sajikumar, N. & Thandaveswara, B.S. (1999). A non-linear rainfall-runoff model using an artificial neural network. *Journal of Hydrology* , 216: 32-55.

Sarangi, A., Madramootoo, C. A., Enright, P., & Prasher, S. O. (2007). Evaluation of three unit hydrograph models to predict the surface runoff from a Canadian watershed. *Water Resources Management*, *21*(7), 1127-1143.

Sarkar, A., & Kumar, R. (2012). Artificial neural networks for event based rainfall–runoff modeling. *Journal of Water Resource and Protection*, 04:891–897. doi:org/10.4236/jwarp.2012.410105.

Scheidegger, A.E. (1970). Theoretical Geomorphology. George Allen and Unwin, London.
doi: 10.1007/978-3-662-01025-9.

Schumn, S.A. (1956). Evolution of drainage systems and slopes in badlands at Perth Amboy, New Jersey. *Geological Society of American Bulletin*, 67: 597- 646.

SCS, 1986. "Urban Hydrology for Small Watersheds, Technical Report 55". Technical Report tr55, USDA, Springfield, VA. xi, 23, 38, 39, 142

Seiller, G., Anctil, F. & Perrin, C. (2012). Multimodel evaluation of twenty lumped hydrological models under contrasted climate conditions. *Hydrology and Earth System Sciences*, 16: 1171-1189. doi:10.5194/hess-16-1171-2012, 2012.

Senadeera, W. (2016). Morphmetric Analysis of Randenigala Reservoir catchment using GIS. *International Journal of Multidisciplinary Studies (IJMS)*,

Shamsudin, S. & Hashim, N. (2002). Rainfall runoff simulation using MIKE11 NAM. *Jurnal Kejuruteraan Awam (Journal of Civil Engineering)*, 15 (2), pp. 1 – 13.

Sharma R, Sahai B. & Karale, R.L. (1985). Identification of erosion-prone areas in a part of the Ukai catchment. In: Proceedings sixth Asian conference on remote sensing National Remote Sensing Agency Hyderabad, pp 121–126.

Sharma, S. B., & Singh, A. K. (2014). Assessment of the flood potential on a lower tapi basin tributary using SCS-CN method integrated with remote sensing & GIS data. *Journal of Geographical Natural Disaster*, *4*(128), 2167-0587.

Sharif, H. O., Al-Zahrani, M., & Hassan, A. E. (2017). Physically, Fully-Distributed Hydrologic Simulations Driven by GPM Satellite Rainfall over an Urbanizing Arid Catchment in Saudi Arabia. Water, 9(3), 163.

Shaw, E.M. (1983). Hydrology in Practice. Chapman and Hall, London, UK., Pages: 569.Sherman, L. K. (1942). Hydrograph of runoff"", Physics of the Earth, IX, hydrology, O. E. Meinzer, ed., McGraw-Hill, New York, 1942.

Sherman, L. K., (1949). The unit hydrograph method", Physics of the Earth, IX, hydrology, O. E. Meinzer, ed., McGraw-Hill, New York, 1949.

Sharma,B.S. & Singh, A.K. (2014). Assessment of the Flood Potential on a Lower Tapi Basin Tributary using SCS-CN Method integrated with Remote Sensing & GIS data. *Journal of Geography & Natural Disaster*, 4:2. doi.org/10.4172/2167-0587.1000128

Shirke, Y., Kawitkar, R., & Balan, S. (2012). Artificial neural network based runoff prediction model for a reservoir. *International Journal of Engineering Research and Technology*, 1(3): 1–4.

Siriwardena, L., Finlayson, B.L. & McMahon, T.A. (2006).The impact of land use change on catchment hydrology in large catchments: The Comet River, Central Queensland, Australia, *Journal of Hydrology*, 326: 1(4): 199-214. https://doi.org/10.1016/j.jhydrol.2005.10.030.

Singh, V.P., Arora, M. & Goel, N. K. (2006). Effect of climate change on runoff of a glacierized Himalayan basin. *Hydrological Processes*, 20: 1979–1992. doi:10.1002/hyp.5991

Singh, V. P. (1988). Hydrologic systems. Volume I: Rainfall-runoff modeling. *Prentice Hall, Englewood Cliffs New Jersey. 1988. 480*.

Singh, V. P., & Woolhiser, D. A. (2002). Mathematical modelling of watershed hydrology. *Journal of Hydrologic Engineering*, 7:270-292.

Sinha, S., Rode, M. & Borchardt, D. (2016). Examining runoff generation processes in the Selke catchment in central Germany: Insights from data and semi-distributed numerical model. Journal of Hydrology: Regional Studies, 7: 38 – 54, https://doi.org/10.1016/j.ejrh.2016.06.002

Sivakumar, V., Biju, C. & Deshmukh, B. (2011). Hypsometric analysis of Varattaru river basin of Harur Taluk, Dharmapuri Districts, Tamilnadu, India using geomatics technology. *International Journal of Geomatics and Geosciences*, 2: 1:241-247.

Smith, K.G. (1950). Standards for grading texture of erosional topography. *American Journal of Science*, 248:655-668.

Smith, M.B., Seo, D.J., Koren, V.I., Reed, S.M., Zhang, Z., Duan, Q., Moreda, F. & Cong, S. (2004). The distributed model intercomparison project (DMIP): motivation and experiment design. *Journal of Hydrology*, 298; 1(4): 4-26. doi:10.1016/j.jhydrol.2004.03.040.

Soni, S. (2016). Assessment of morphometric characteristics of Chakrar watershed in Madhya Pradesh using geospatial technique. *Applied Water Science*, 1-14. doi 10.1007/s13201-016-0395-2.

Spruill, C.A., Workman, S.R. & Taraba, J.L. (2000). Simulation of daily and monthly stream discharge from small watershed using the SWAT Model. *Transactions of the ASAE. American Society of Agricultural Engineers*, 43: 1431-1439.

Strahler, A.N. (1952). Hypsometric (area-altitude) analysis of erosional topography. *Geological Society of America Bulletin*, 63: 1117-1141.

Strahler, A.N. (1964). Quantitative geomorphology of drainage basins and channel networks, in *Handbook of Applied Hydrology*, V. T. Chow, Ed., section 4–11, McGraw-Hill, New York, NY, USA,1964.

Sudheer, K. P., Gosain, A. K., & Ramasastri, K. S. (2002). A data-driven algorithm for constructing artificial neural network rainfall–runoff models. *Hydrological Processes,* 16: 1325–1330.

Suliman, A. H. A., Gumindoga, W., Katimon, A. & Darus, I. Z. M. Semi-distributed Rainfall-runoff Modeling utilizing ASTER DEM in Pinang Catchment of Malaysia. *Sains Malaysiana,* 43(9), pp. 1379–1388.

Suresh, R. (2000). Soil and water conservation engineering, 3rd edn. 24. Watershed-concept and management, pp 785–813

Sui, D.Z. & Maggio, R.C. (1999). Integrating GIS with hydrological modeling: practices, problems, and prospects. *Computers, Environment and Urban Systems*, 23:1:33-51. doi.org/10.1016/S0198-9715(98)00052-0.

Sui, D.Z. (1998). GIS-based Urban Modelling: Practices, Problems, and Prospects. International *Journal of Geographic Information Sciences*, 12: 651-671.

Sun, Z., Lotz, T., & Chang, N.-B. (2017) .Assessing the long-term effects of land use changes on runoff patterns and food production in a large lake watershed with policy implications. Journal of Environmental Management, 204, pp. 92-101. DOI: 10.1016/j.jenvman.2017.08.043.

Syed, A.U-R. (2012). Hydrologic analysis of a semi-arid watershed using kinematic wave and SCS flow models. *Dissertation of Doctor of Philosophy*. Michigan State University.

Széles, B., Parajka, J., Blöschl, G., Oismüller, M. & Hajnal, G. (2016). Sensitivity of rainfall-runoff processes in the Hydrological Open Air Laboratory. *Geophysical Research Abstracts*, 18, EGU2016-433.

Tarboton, D.G. (1997). A new method for the determination of flow directions and upslope areas in grid digital elevation models. *Water Resour. Res., 33*(2), 309-319.

Tarboton, D.G., R. L. Bras, and I. Rodriguez-Iturbe,. (1991). On the extraction of channel networks from digital elevation data, Hydrol. Process., 5(1), 81-100.

Tarboton, D.G. (1997). A New Method for the Determination of Flow Directions and Contributing Areas in Grid Digital Elevation Models. *Water Resources Research,* 33(2): 309-319.

Tarboton, D.G. (2003). Rainfall-Runoff Processes, http://www.webs1.uidaho.edu/ch/notes/ intro.pdf.

Tedela, N. H., McCutcheon, S. C., Rasmussen, T. C., Hawkins, R. H., Swank, W. T., Campbell, J. L., Adams, M. B., Jackson, C. R. & Tollner, E. W. (2012). Runoff curve numbers for 10 small forested watersheds in the mountains of the Eastern United States. *Journal of Hydrologic Engineering*, 17: 1188 – 1198.

Tollan, A. (2002). Land-use change and floods: what do we need most, research or management?. *Water Science and Technology*, *45*(8), 183-190.

Tsoukalas, I., Kossieris, P., Efstratiadis, A., & Makropoulos, C. (2016). Surrogate-enhanced evolutionary annealing simplex algorithm for effective and efficient optimization of water resources problems on a budget. *Environmental Modelling & Software*, *77*, 122-142

Tucker, G. E., & Bras, R. L. (1998). Hillslope processes, drainage density, and landscape morphology. *Water Resources Research*, 34(10): 2751–2764. doi:10.1029/98WR01474.

UN. 2004. A/RES/58/217. The United Nations 58th General Assembly

United States Army Corps of Engineers (USACE). (2000). United States Army Corps of Engineers (USACE).Engineering and design — Design and construction of levees (EM 1110-2-1913).

USDA, (1986). USDA (United States Department of Agriculture Natural Resources Conservation Service), 1986. Urban Hydrology for Small Watersheds, Technical Release 55, second ed., NTIS PB87-101580, Springfield, Virginia,

Usul, N., & Yilmaz, M. (2002). Estimation of instantaneous unit hydrograph with Clark's Technique in GIS. In Proceedings of 2002 ESRI international user conference. ESRI on-line, San Diego. http://proceedings. esri. com/library/userconf/proc02.

UNESCO, (1985). *Teaching aids in hydrology*, Universitaires de France, Vendome

Wakigari, S. A. (2017). Evaluation of Conceptual Hydrological Models in Data Scarce Region of the Upper Blue Nile Basin: Case of the Upper Guder Catchment. *Hydrology*, 4(4), 59.

Wolf, M., Pfennig, B., Krause, P., Flügel, W.A., 2009. Delineation of topographic process entities using SRTM for hydrological modelling. Proceedings of the 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation in Cairns, Australia, 2021– –2027.

Varikoden, H., Preethi, B., Samah, A.A. & Babu, C.A. (2011). Seasonal variation of rainfall characteristics in different intensity classes over Peninsular Malaysia. *Journal of Hydrology*, 404; 1(2): 99-108. doi: 10.1016/j.jhydrol.2011.04.021.

Vaze, J., Jordan, P., Beecham, R., Frost, A. & Summerell, G. (2011). (eWater Cooperative Research Centre 2011). Guidelines for rainfall runoff modelling*: Towards best practise model application*. ISBN: 978-1-921543-51-7.

Vaze, J., Barnett, P., Beale, G.T.H., Dawes, W., Evans, R., Tuteja, N.K., Murphy, B., Geeves, G. & Miller, M. (2004). Modelling the effects of landuse change on water and salt delivery from a catchment affected by dryland salinity in southeast Australia. *Hydrological Processes*, 18: 1613-1637.

Vansteenkiste, T., Ntegeka, V. & Willems, P. (2014). Ensemble catchment hydrological modelling for climate change impact analysis. *Geophysical Research Abstracts*, 16, EGU2014-13372-1

Vieux, B. E., & Bedient, P. B. (2004). Assessing urban hydrologic prediction accuracy through event reconstruction. *Journal of Hydrology*, *299*(3), 217-236.

Viji, R., Prasanna, P. R., & Ilangovan, R. (2015). Gis based SCS - CN method for estimating runoff in Kundahpalam watershed, Nilgries District, Tamilnadu. *Earth Sciences Research Journal*, *19*(1): 59–64. http://doi.org/10.15446/esrj.v19n1.44714

Viney, N.R., Croke, B. F.W., Breuer, L., Bormann, H., Bronstert, A., Frede, T.H., Hubrechts, G.T., Huisman, J.A., Jakeman, A.J., Kite, G.W., Lanini, J., Leavesley, G., Lettenmaier, D.P., Lindström, G., Seibert, J., Sivapalan, M. & Willems, P. (2005). *Ensemble modelling of the hydrological impacts of land use change.* In: Zerger, A., Argent, R.M. (Eds.), MODSIM 2005 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, pp. 2967– 2973. ISBN: 0-9758400-2-9.

Ward, R.C. & Robinson, M. (2000). Principles of Hydrology, McGraw- Hill, Maidenhead, UK, 4th edition. doi: 10.1016/S0098-3004(97)00081-2

Wijesekara, G. N., Gupta, A., Valeo, C., Hasbani, J. G., Qiao, Y., Delaney, P., & Marceau, D. J. (2012). Assessing the impact of future land-use changes on hydrological processes in the Elbow River watershed in southern Alberta, Canada. *Journal of Hydrology*, 412(413):220–232. http://dx.doi.org/10.1016/j.jhydrol.2011.04.018

Willgoose, G. & Hancock, G. (1998). Revisiting the hypsometric curve as an indicator of form and process in transport-limited catchment. *Earth Surface Processes and Landforms***,** 23; 611–623

Willems, P. (2000). Probabilistic modelling of the emission receiving surface waters. Ph.D Thesis, Faculty of Engineering, Katholieke Universiteit, Leuven, Belgium.

Wilson, C. B., Valdes, J. B. & Rodriguez-Iturbe, I. (1979). On the influence of the spatial distribution of rainfall on storm runoff. *Water Resources Research,* 15(2): 321–328.

Wu, Z., Wu, J. & Lu. (2016). A one-way coupled atmospheric-hydrological modeling system with combination of high-resolution and ensemble precipitation forecasting. *Frontiers of Earth Science*, 10: 432. doi:10.1007/s11707-015-0535-2

Xu, J.H., Chen, Y.N., Li, W.H. & Dong, S. (2008). Long-term trend and fractal of annual runoff process in mainstream of Tarim River. *Chinese Geographical Science*, 18(1): 77–84, DOI: 10.1007/s11769-008- 0077-6

Yan, B., Fang, N. F., Zhang, P. C., & Shi, Z. H. (2013). Impacts of land use change on watershed streamflow and sediment yield: an assessment using hydrologic modelling and partial least squares regression. *Journal of Hydrology*, *484*, 26-37.

Yin, J., He, F., Xiong, Y. J., & Qiu, G. Y. (2017). Effects of land use/land cover and climate changes on surface runoff in a semi-humid and semi-arid transition zone in northwest China. *Hydrology and Earth System Sciences (HESS)*, 21: 183-196. doi:10.5194/hess-21-183-2017, 2017.

Youssef, A.M., Pradhan, B. & Hassan, A.M. (2011). Flash flood risk estimation along the St. Katherine road, southern Sinai, Egypt using GIS based morphometry and satellite imagery. *Environmental Earth Sciences*, 62: 611. doi:10.1007/s12665-010-0551-1

Yu, P.-S. & Wang, Y.-C. (2009). Impact of climate change on hydrological processes over a basin scale in northern Taiwan. *Hydrological Processes*, 23: 3556–3568. doi:10.1002/hyp.7456

Yu, D. and Xie, P. and Dong, X. and Hu, X. and Liu, J. and Li, Y. and Peng, T. and Ma, H. and Wang, K. and Xu, S. (2017). Improvement of the SWAT model for event-based flood forecasting on a sub-daily time scale. *Hydrology and Earth System Sciences Discussions.* 1-24.DOI: 10.5194/hess-2017-180

Zhang, H., Huang, G.H & Wang, D. (2013). Establishment of channel networks in a digital elevation model of the prairie region through hydrological correction and geomorphological assessment. *Canadian Water Resources Journal*. 38(1):12–23.

Zhang, W. & Montgomery, D. R. (1994). Digital elevation model grid size, landscape representation, and hydrologic simulations. *Water Resource Research, 30*(4); 1019-1028.

Zhang, L., Ofosu, D.A. & Kabo-Bah A.T. (2014). Integration of Geographical Information Science (GIS) Technology in Hydrological Modeling: A Critical Review. *Advanced Materials Research*, 838-841: 2284-2291.

Zhang, H. Li, Z., Saifullah, M., Li., Q & Li, X. (2016). Impact of DEM resolution and spatial scale: Analysis of influence factors and parameters on Physically based distributed model. *Advances in Meteorology*, Vol. 2016, Article ID 8582041, 10. doi: http:dx.doi.org/10.1155/2016/8582041.

Zhang, X., Srinivasan, R., Zhao, K., & Liew, M. V. (2009). Evaluation of global optimization algorithms for parameter calibration of a computationally intensive hydrologic model. *Hydrological Processes*, *23*(3), 430-441.

Zlatanović, N., & Gavrić, S. (2013). Comparison of an automated and manual method for calculating storm runoff response in ungauged catchments in Serbia. *Journal of Hydrology and Hydromechanics*, *61*(3), 195-201.