ANGGARAN HASILAN AIR TADAHAN SUNGAI KELANTAN DENGAN MENGGUNAKAN TEKNIK PENDERIAAN JAUH

MOHD HILMI P. RAMLI

Tesis ini dikemukakan sebagai memenuhi
syarat penganuerahan ijazah
Doktor Falsafah (Remote Sensing)

Fakulti Alam Bina dan Ukur
Universiti Teknologi Malaysia

OKTOBER 2019

DEDIKASI

Untuk ALLAH S.W.T yang memberi kerahmatan, kekuatan, peluang dan keajaiban, Untuk yang diingati ibu bapa tercinta P.Ramli bin Karim dan Mastura binti Ibrahim, Untuk yang disayangi isteri Wan Nurulhanaa' Wan Mohamed, anak-anak Ahmad Haarith Ajwad, Nurul Huda Amna, Nurhaniyyah Afia, Ahmad Haziq Ayman dan Ahmad Hanif Awaab, dan Untuk adik-adik yang dikasihi yang menyedarkan erti hidup di dunia ini.

PENGHARGAAN

Alhamdulilah, syukur ke hadrat ALLAH S.W.T dengan limpah dan izin-NYA dapat juga saya menyiapkan tesis PhD ini. Dengan rasa rendah diri di sini, saya ingin mengambil kesempatan mengucapkan setinggi-tinggi penghargaan kepada penyelia saya Prof Madya Dr. Ab Latif Ibrahim dan Prof Dr. Kasturi Dewi Kanniah yang telah banyak menolong saya dalam memberi panduan, tunjuk ajar serta nasihat yang cukup berguna kepada saya sepanjang menyiapkan tesis PhD ini. Saya juga ingin mengucapkan setinggi-tinggi ucapan terima kasih kepada Dr. Nurul Hazrina Idris yang juga banyak membantu saya untuk menyiapkan tesis ini. Tidak lupa juga saya ingin mengucapkan ribuan terima kasih kepada rakan-rakan seperjuangan terutamanya Tam Tze Huey dan Tan Mou Leong yang banyak memberi tunjuk ajar serta nasihat berguna kepada saya. Menyedari hakikat saya hanya insan yang lemah, saya berdoa dan memohon pada ALLAH S.W.T agar mereka yang saya sebutkan di atas ini dipermudahkan dan diperbanyakan segala rezeki yang halal dan kerahmatan yang berkekalan. Hanya ALLAH S.W.T sahaja yang mampu membalas segala jasa baik kalian kepada saya.

ABSTRAK

Pengurusan sumber air yang berkesan sangat penting kerana dapat memastikan ketersediaan sumber air yang boleh menyokong keperluan air yang berubah-ubah sepanjang tempoh perancangan yang dipilih dengan cara yang boleh dipercayai dan kos efektif. Cabaran utama yang dihadapi oleh pengurusan sumber air pada hari ini adalah peningkatan permintaan air bersih di Malaysia. Di Kelantan, anggaran permintaan untuk penggunaan air bersih dijangka meningkat sebanyak 450 juta liter kepada 1,000 juta liter menjelang tahun 2050 berbanding 2019. Beberapa kajian telah dijalankan menggunakan teknik pengesan jarak jauh untuk menganggar hasilan air di Malaysia. Kajian ini menganggarkan hasilan air dengan menggunakan model Alat Penilaian Tanah & Air (SWAT) dan teknik penderiaan jauh di lembah Sungai Kelantan. Anggaran hasilan air menggunakan teknik penderiaan jarak jauh telah disahkan terhadap model SWAT bagi tahun 2000 hingga 2014. Analisis spatial dan masa dijalankan untuk mengkaji kesan perubahan penggunaan tanah terhadap anggaran hasil air bagi 13 tadahan air di Lembangan Sungai Kelantan pada tahun 2000, 2008, dan 2013. Scenario bagi Laluan Konsentrasi Perwakilan (RCP) 2.6 dan RCP 8.5 daripada model Model Peredaran Am (GCM) Projeck Perbandingan Model Gabungan Fasa 5(CMIP5) telah ditentukur menggunakan dari Model SWAT untuk meramalkan hasilan air masa hadapan bagi tahun 2015 -2044 dan tahun 2045-2074 berdasarkan tahun asas dari tahun 1975-2004. Keputusan menunjukkan bahawa anggaran hasilan air berasaskan penderiaan jauh telah memperolehi pekali korelasi yang boleh diterima dan memuaskan bagi skala tahunan dan bulanan. Anggaran hasilan air tahunan dari tahun 2000 hingga 2014 adalah 1,280 ± 207.7 mm/tahun untuk model SWAT dan 1,687 ± 373.9 mm/tahun untuk teknik penderiaan jauh. Perubahan guna tanah untuk tahun 2000, 2008, dan 2013 tidak memberi kesan yang ketara ke atas jumlah air yang dihasilkan. Faktor utama yang mempengaruhi model hasilan air berasaskan penderiaan jauh adalah jumlah hujan dan penyejatpeluhan RCP 2.6 menunjukkan peningkatan hasil air pada tahun 2015-2044 sebanyak 16.6% dan, untuk tahun 2045-274, sebanyak 14.22%, sementara RCP 8.5 menunjukkan peningkatan 26.46% untuk tahun 2015-2044 dan 24.36% untuk tahun 2045-2074. RCP 8.5 menunjukkan peningkatan yang lebih tinggi dalam hasil air berbanding dengan RCP 2.6 untuk tahun 2015-2044 dan 2045-2074. Berdasarkan hasil penemuan kajian ini, pengemasan model hasilan air berasaskan penderiaan jauh diperlukan dan perlu mempertimbangkan lebih banyak parameter hidrologi dan data guna tanah untuk meningkatkan kecekapannya.

ABSTRACT

Effective water resource management is of great importance as it ensures the availability of water resource that can support the changing water requirements over the chosen planning period in a reliable and cost-effective manner. The main challenge facing water resource management today is the growing demand for clean water in Malaysia. In Kelantan, the estimated demand for clean water use is expected to increase from 450 million to 1,000 million litres by 2050 as compared to 2019. Few studies have been conducted using remote sensing technique to estimate water yield in Malaysia. The present study estimated water yield using Soil & Water Assessment Tool (SWAT) model and remote sensing technique in Kelantan River basin. Estimation of water yield using remote sensing technique was validated against the SWAT model for the years 2000 to 2014. Spatial and temporal analyses were conducted to examine the effect of land use changes on water yield estimates for 13 sub-catchments in Kelantan River Basin in 2000, 2008, and 2013. Scenarios of Representative Concentration Pathways (RCP) 2.6 and RCP 8.5 of the General Circulation Model (GCM) Model Coupled Model Intercomparison Project Phase 5 (CMIP5) were calibrated using the SWAT Model to predict the future water yield for 2015-2044 dan 2045-2074 based on the basal years from1975-2004. Results showed that the remote sensing-based water yield estimation had acceptable and satisfactory correlation coefficients of the annual and monthly scales. The annual water yield estimates from 2000 to 2014 were 1,280 ± 207.7 mm/year for SWAT model and 1,687 ± 373.9 mm/year for remote sensing technique. Changes in the land use for the years 2000, 2008, and 2013 showed that there was no significant effect on the amount of water generated. The main factors influencing remote sensing-based water yield model were the amount of rainfall and evapotranspiration. RCP 2.6 showed an increase in 16.6% water yield for 2015-2044 and 14.22% for 2045-274 while RCP 8.5 had similar increases of 26.46% for 2015-2044 and 24.36% for 2045-2074. RCP 8.5 showed a higher rise in water yield in comparison to RCP 2.6 for the years 2015-2044 and 2045-2074. Based on the findings of the study, refinement of the remote sensing-based water yield model is needed and it should take into consideration more hydrological related parameters and land use data in order to improve its efficiency.

SENARAI KANDUNGAN

SENARAI JADUAL

SENARAI RAJAH

SENARAI SINGKATAN

AKSB	-	*Air Kelantan Sdn Bhd*
AMSR-E	-	*Advanced Microwave Scanning Radiometer For Earth Observing Systems*
AMSU-B	-	*Advance Microwave Sounding Unit B*
APHRODITE	-	*Asian Precipitation Highly Resolved Observational Data Integration Towards the Evaluation of Water Resouces*
AR5	-	Laporan *Fifth Assessment*
ARS	-	*Agricultural Research Service*
CCTT	-	*Coldest Cloud* Top *Temperature*
CLM	-	*Community Land Model*
CMIP 5	-	*Coupled Model Intercomparison Project, Phase 5*
CST	-	*Convective Stratiform Technique*
DEM	-	*Digital Elevation Model*
GCM	-	*Global Climate Model* (Model Iklim Global)
GIS	-	*Geographical Information System*/ Sistem Maklumat Geografi

GLDS	-	*The Global Land Data Assimilation System/ Sistem Asimilasi Data Daratan Global*
GPCC	-	*Global Precipitation Climatology Centre*
GPCP	-	*Global Precipitation Climatology Project*
GPS	-	*Global Position System*
GSFC	-	*Goddard Space Flight Center*
HDISC	-	*Hydrology Data and Information Services Center*
HRU	-	*Hydrologic Response Units/Hidrologi Respon Unit*
HSK	-	hutan simpan kekal
InSAR	-	*Radar Aperture Radar Interferometric*
IPCC	-	*Intergovernmental Panel on Climate Change*
IR	-	*Infrared* / Jalur inframerah
JMM	-	Jabatan Meteorologi Malaysia
JUPEM	-	Jabatan Ukur dan Pemetaan Malaysia
JPS	-	Jabatan Pengairan dan Saliran
KADA	-	Lembaga Kemajuan Pertanian
LAI	-	*Leaf Area Index*

LIS	-	Sistem Maklumat Tanah
LRA	-	Loji Rawatan Air
ME	-	*Mean Error*
ME	-	*mean- error*
MHS	-	*Microwave Humidity Sounder*
MODIS	-	*Moderate Resolution Imaging Spectroradiometer*
NASA	-	*The National Aeronautics and Space Administration*
NCEP/NCAR	-	*National Centers for Environment Prediction / National Center for Atmospheric Research*
NDVI	-	*Normalized Difference Vegetation Index*
NetCDF	-	*Network Common Data Form*
NSE	-	*Nasch-Sutcliffe Efficiency*
NME	-	*normalised* ME
NOAA AVHRR	-	*The National Oceanic and Atmospheric Administration* *Advance Very HighResolution Radiometer*
NOAA NCEP	-	*National Oceanic and Atmospheric Administration* *National Centers for Environmental Prediction*
NPP	-	*Net Primary Production*

NRMSE	-	*normalised* RMSE
NSE	-	*Nasch-Sutcliffe Efficiency*
ObsCV	-	*coefficient of variation of observation*
PERSIANN	-	*Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks*
PMW	-	Pemancar Gelombang Pasif
QUEST-GSI	-	*Quantifying and Understanding the Earth System–Global Scale Impacts*
PR	-	*Precipitation Radar*
RB	-	*Relative Bias*
RCM	-	Model Iklim Serantau
RCP	-	*Representative Concentration Pathways*
RMSE	-	*root-mean-square error*
SEBAL	-	*The Surface Energy Balance Algorithm for Land*
SSMI	-	*Special Sensor Microwave/Imager*
SSMIS	-	*Special Sensor Microwave Imager/Sounder*
SRTM	-	*Shuttle Radar Topography Mission*
SVAT	-	*Soil Vegetation Atmosphere Transfer*

SWAT	-	*Soil Water Assesment Tool*
SWIM	-	*Soil and Water Integrated Model*
TMI	-	*TRMM Microwave Imager*
TRMM	-	*Tropical Rainfall Measuring Mission*
TMPA	-	*Multisatellite Precipitation Analysis*
UNEP	-	*United Nations Environment Programme*
UPEN	-	Unit Perancang Ekonomi Negeri Kelantan
VIC)	-	*Variable Infiltration Capasity*
VIS	-	Jalur Nampak
WEAP	-	*Water Evaluation And Planning*

SENARAI SIMBOL

Q	-	aliran sungai
P/*P*	-	Hujan
I	-	aliran air ke dalam kawasan tadahan air
ET	-	Sejatpeluhan
G	-	aliran air bawah tanah
ΔS	-	perubahan dalam simpanan kelembapan
D	-	lencongan daripada kawasan tadahan air
DayResp/ NightResp	-	Wap air
Tday	-	Suhu pagi
Tday	-	Suhu malam
λE_t	-	Sejatpeluhan sebenar
SW_t	-	kandungan air tanah akhir
SW_0	-	kandungan air tanah awal pada hari i
$_i$	-	hari dalam unit mm
R_{day}	-	jumlah hujan pada hari i
Q_{surf}	-	jumlah permukaan larian pada hari i
E_a	-	jumlah sejatpeluhan pada hari i
W_{seep}	-	jumlah air memasuki tadahan dari profil tanah di hari i
Q_{gw}	-	jumlah aliran pulangan pada hari
WYLD	-	jumlah hasilan air
*SUR*Q	-	air larian permukaan
*LAT*Q	-	aliran sub-tadahan untuk aliran sungai

*GW*Q	-	air bawah tanah
T*LOSS*	-	jumlah kehilangan air
R_n	-	sinaran bersih
G_o	-	aliran haba tanah
ρ	-	purata densiti udara pada tekanan tetap
$c\rho$	-	nilai spesifik haba pada tekanan tetap
$(e_s – e_a)$	-	defisit tekanan wap
R_{ah}	-	rintangan aerodinamik untuk pengangkutan haba
r_s	-	rintangan kanopi
λE_o	-	sejatpeluhan pontensi
α_{pet}	-	koefisen 1.28
Δ	-	kecerunan tekanan wap ketepuan pada suhu udara
γ	-	nilai konstant untuk *psychrometric*
ρ	-	purata densiti udara pada tekanan tetap
H_{net}	-	aliran haba
G	-	aliran haba tanah
ΔS	-	perubahan dalam simpanan air tanih
$f(\phi)$	-	kelembapan tanih
M	-	jumlah lengasan tanih pada kedalaman 20 cm
H	-	aliran haba rasa
λ	-	aliran haba pendam iaitu tenaga yang diperlukan untuk proses pengewapan air
$(T_s - T_a)$	-	rintangan untuk perpindahan aliran haba rasa
ET_o	-	sejatpeluhan potensi
R_a	-	*extraterrestrial radiation*
T_x	-	purata nilai maksimum bulanan

T_n	-	purata nilai suhu minimum bulanan
I_{on}	-	*extraterrestrial radiation*
I_{SC}	-	nilai tetap solar iaitu jumlah tenaga solar untuk gelombang panjang di kawasan yang terdedah kepada sinar 100 matahari
E_o	-	pembetulan untuk *eccentricity* bagi pusingan orbit bumi yang mengelilingi matahari
sr	-	waktu pagi
ss	-	waktu petang
dt	-	unit masa mengikut jam
E_a	-	jumlah sejatpeluhan sebenar
E_{can}	-	jumlah sejatan daripada air di kanopi tumbuhan
$R_{INT(i)}$	-	jumlah air hujan permulaan yang turun di kanopi tumbuhan
$R_{INT(f)}$	-	jumlah air hujan yang terakhir di kanopi tumbuhan
$E_{soil,z}$	-	sejatan berdasarkan kedalaman lapisan tanah
E_S''	-	air tanah tersejat untuk sehari
$E_{soil,ly}$	-	keperluan sejatan untuk lapisan tanah
$E_{soil,zl}$	-	keperluan untuk lapisan paling bawah
$E_{soil,zu}$	-	keperluan sejatan untuk lapisan paling atas
$E'_{soil,ly}$	-	keperluan sejatan untuk lapisan tanah yang telah diubah mengikut kandungan air
SW_{ly}	-	kandungan air di dalam tanah
WP_{ly}	-	kandungan air di titik pemberat lapisan tanah
$T_{delta,daily}$	-	uhu delta harian yang dikecilkan skala
$T_{obs,daily}$	-	suhu harian

$\bar{T}_{fut}$	-	purata suhu bulanan GCM untuk tempoh masa hadapan
$\bar{T}_{bas}$	-	dalah purata suhu bulanan GCM pada tempoh asas
$P_{dealta,daily}$	-	adalah hujan harian yang dikecilkan skala
$P_{obs,daily}$	-	hujan harian
$\bar{P}_{fut}$	-	purata hujan bulanan GCM untuk tempoh masa hadapan
$\bar{P}_{bas}$	-	purata hujan bulanan GCM pada tempoh asas

SENARAI LAMPIRAN

RUJUKAN

Abbaspour, K. C., Yang, J., Maximov, I., Siber, R., Bogner, K., Mieleitner, J., dan Srinivasan, R. (2007). Modelling hydrology and water quality in the pre-alpine/alpine Thur watershed using SWAT. *Journal of Hydrology*. 333(2-4), 413-430.

Abbaspour, K. C., Van Genuchten, M. T., Schulin, R., dan Schläppi, E. (1997). A sequential uncertainty domain inverse procedure for estimating subsurface flow and transport parameters. *Water Resources Research*. 33(8), 1879-1892.

Abbott, M.B., dan Refsgaard, J.C. (2012). *Distributed hydrological modelling (Vol. 22)*. Springer Science & Business Media.

Aber, J.D., dan Driscoll, C.T. (1997). Effects of land use, climate variation, and N deposition on N cycling and C storage in northern hardwood forests. *Global Biogeochemical Cycles*. 11(4), 639-648.

Aber, J.D., Reich, P.B., dan Goulden, M.L. (1996). Extrapolating leaf CO 2 exchange to the canopy: a generalized model of forest photosynthesis compared with measurements by eddy correlation. *Oecologia*. 106(2), 257-265.

Adeniyi G. Adeogun, Bolaji F. Sule, Adebayo W. Salami, dan Michael O. Daramola (2014). Validation of SWAT Model for Prediction of Water Yield and Water Balance: Case Study of Upstream Catchment of Jebba Dam in Nigeria. *International Journal of Mathematical, Computational, Natural and Physical Engineering*. 8(2), 264- 270.

Akhavi, M. S. (1980). Water Resources Investigations In West Central Iran Using Landsat Data. *Journal of the American Water Resources Association*. 16(6), 987-994.

Ali M.F., Saadon A., Abd Rahman N.F., dan Khalid K. (2014). An Assessment of Water Demand in Malaysia Using Water Evaluation and Planning System. In: Hassan R., Yusoff M., Ismail Z., Amin N., Fadzil M. (eds) *InCIEC 2013*. Springer, Singapore.

Allen, R.G., Pereira, L.S., Raes, D., dan Smith, M. (1998). *Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements*. FAO Irrigation and Drainage Paper No. 56 Food and Agriculture Organization (FAO), Rome, Itali.

Arabi, M., Govindaraju, R. S., Hantush, M. M., dan Engel, B. A. (2006). Role of Watershed Subdivision on Modeling the Effectiveness of Best Management Practices With Swat. *Journal of the American Water Resources Association*. 42(2), 513-528.

Arnold, J. G., dan Fohrer. N. (2005). SWAT2000 : Current Capabilities and Research Opportunities Applied Watershed Modeling. *Hydrological Proc*esses. 19(3), 563-572.

Arnold, J. G., Moriasi, D. N., Gassman, P. W., Abbaspour, K. C., White, M. J., Srinivasan, R., dan Kannan, N. (2012). *SWAT: Model use, calibration, and validation*. Transactions of the ASABE, 55(4), 1491-1508.

Azhar, G. (2000). Managing Malaysian water resources development. *Buletin Kesihatan Masyarakat Isu Khas*. 200, 40-58.

Baines, P. G., dan Folland, C. K. (2007). Evidence for a rapid global climate shift across the late 1960s. *Journal of Climate*. 20, 2721–2744.

Balasubramanian, A., dan Nagaraju, D. (2017). The Hydrologic Cycle.

Bárdossy, A. (2007). Calibration of hydrological model parameters for ungauged catchments. *Hydrology and Earth System Sciences*. 11, 703-710

Bastiaanssen, W., dan Bos, M. (1999). Irrigation and Drainage Systems 13: 291.

Bastiaanssen, W.G.M. (1995). *Regionalization of Surface Flux Densities and Moisture Indicators in Composite Terrain: A Remote Sensing Approach under Clear Skies in Mediterranean Climates*. Ph. D. Thesis, Wageningen Agricultural University.

Bastiaanssen, W.G., dan Chandrapala, L. (2003). Water balance variability across Sri Lanka for assessing agricultural and environmental water use. *Agricultural water managemen*t, 58(2), 171-192.

Beven, K. (2006). On undermining the science?. *Hydrological Processes: An International Journal*. *20*(14), 3141-3146.

Bhat, A. (2004). Policy, politics, and water management in the Guadalquivir River Basin, Spain. *Water Resources Research*. 40,1-11.

Bloschl, G. (2005). Rainfall-runoff modelling of ungauged catchments. *Encyclopaedia of Hydrological Sciences*.

Bloschl, G., dan Montanari, A. (2010). Climate change impacts—Throwing the dice?, *Hydrological Processes*. 24, 374–381.

Bonell, M. (1991). Progress in runoff and erosion research in forests. *In: Proceedings from 10th world forestry congress, Vol. 2*. Paris - 1991, Revue Forestiere Francaise, Hors Serie No 2,101-113.

Booth, M.S., dan Campbell, C. (2007). Spring nitrate flux in the Mississippi River basin: A landscape model with conservation applications. *Environmental Science & Technology*. 41:5410–5418.

Bourdin, D. R., Fleming, S. W., dan Stull, R. B. (2012). Streamflow modelling: a primer on applications, approaches and challenges. *Atmosphere-Ocean*. 50(4), 507-536.

Boutkan, E., dan Stikker, A. (2004). Enhanced water resource base for sustainable integrated water resource management. *Natural Resources Forum*. 28,150–154.

Brad, R., dan Letia, I.A. (2002). Extracting cloud motion fromsatellite image sequences. *Proc. Seventh Int. Conf. on Con-trol, Automation, Robotics and Vision Singapore*. Singapore, IEEE, 1303–1307.

Brown, J. E. (2006). An analysis of the performance of hybrid infrared and microwave satellite precipitation algorithms over India and adjacent regions. *Remote Sensing of Environment*. 101(1), 63-81.

Brown, A.E., Zhang, L., McMahon, T.A., Western, A.W., dan 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(1-4), 28-61.

Bruijnzeel, L.A., dan Sampurno, S.P., (1990). *Hydrology of moist tropical forests and effects of conversion: a state of knowledge review* (224). Amsterdam: Free University.

Bruijnzeel, L.A., (2004). Hydrological functions of tropical forests: not seeing the soil for the trees?. *Agriculture, ecosystems & environment*. 104(1), 185-228.

Bussières, E., Gilly, F. N., Rouanet, P., Mahé, M. A., Roussel, A., Delannes, M., dan Richaud, P. (1996). Recurrences of rectal cancers: results of a multimodal approach with intraoperative radiation therapy. *International Journal of Radiation Oncology, Biology and Physics*. 34(1), 49-56.

Calder, I.R., Wright, I.R., dan Murdiyarso, D. (1986). A study of evaporation from tropical rain forest -West Java. *Journal of Hydrology*. 89(1-2), 13-31.

Cardwell, H. E., Cole, R. A., Cartwright, L. A., dan Martin, L. A. (2006). Integrated water resources management: definitions and conceptual musings. *Journal of contemporary water research & education*, 135(1), 8-18.

Chan, N. W. (1995). Flood disaster management in Malaysia: an evaluation of the effectiveness of government resettlement schemes. *Disaster Prevention and Management: An International Journal*. 4(4), 22-29.

Chan, N.W. (1998). The current water crisis: what went wrong? *Aliran Monthly*. 18(5): 14-18.

Chan, C.H. (2003). *Effects of Secondary Tropical Forest Clearing on Streamflow Characteristics*. Doctor Philosophy, Universiti Teknologi Malaysia, Skudai

Chan, N. W. (2004). *Managing water resources in the 21st century: involving all stakeholders towards sustainable water resources management in Malaysia*. Centre for Graduate Studies, Universiti Kebangsaan Malaysia.

Chapagain, A.K.(2006). *Globalization of Water* .PhD thesis. Technical University of Delft / UNESCO - IHE. The Netherlands.

Chappell, N.A., dan Tych, W. (2004). *Spatially-significant effects of selective tropical forestry on water, nutrient and sediment flows: a modelling-supported review*. in M Bonell & LA Bruijnzeel (eds), Forests, water and people in the humid Tropics : past, present, and future hydrological research for intergrated land and water management. International hydrology, Cambridge University Press, Cambridge, 513-532.

Chemin, Y. (2003). Evapotranspiration of crops by remote sensing using the energy balance based algorithms. *In 1st International Yellow River Forum on River Basin Management (12-15)*. Zhengzhou: International Yellow River Forum.

Chemin, Y., dan Alexandridis, T. (2001). Improving spatial resolution ET seasonal for irrigated rice in Zhanghe, China. *In Proc. of Asian Conference of Remote Sensing*. National University of Singapore, Singapore.

Chen, K., dan Shen, S. F. (1992). Rainfall area identification using GOES Satellite data. *Journal of Irrigation and Drainage Engineering*. 118, 179-190.

Chiew, F.H.S. (2010). Lumped conceptual rainfall-runoffmodels and simple water balance methods: Overview and applications in ungauged and data limited regions. *Geography Compass*. 4(3), 206–225.

Christopherson, R.W. (2000). *Geosystems and Essentials of Oceanography*. Prentice Hall.

Choudhury, B. J., dan De Bruin, H.A.R. (1995). First order ap-proach for estimating unstressed transpiration from meteo-rological satellite data. *Advances in Space Research*.16,167–176.

Clark, R. M. (2014). Securing Water and wastewater systems: Global perspectives. *Water and Environment Journal*. 1-10.

Cornish, P. M., dan Vertessy, R. A. (2001). Forest age-induced changes in evapotranspiration and water yield in a eucalypt forest. *Journal of Hydrology*. 242(1-2), 43-63.

Courault, D., Lacarr`ere, P., Clastre, P., Lecharpentier, P., Jacob, F., Marloie, O., Pr´evot, L., dan Olioso, A. (2003). Estimation of surface fluxes in a small agricultural area using the threedimensional atmospheric model Meso-NH and remote sensing data. *Canadian Journal of Remote Sensing*. 29(6): 741–754.

CSD (1997*). Comprehensive Assesment of the Freshwater Resources of the World*. World Meteorological Organization, Stockholm, Sweden.

David G. Groves, David, Y., dan Claudia T. (2008). Developing and applying uncertain global climate change projections for regional water management planning. *Water Resources Research*. 44,1-16.

Dessu, S. B., dan Melesse, A. M. (2013). *Evaluation and comparison of satellite and GCM rainfall estimates for the Mara River Basin, Kenya/Tanzania*. In Climate change and water resources (pp. 29-45). Springer, Berlin, Heidelberg.

Devi, G. K., Ganasri, B.P., dan Dwarakish, G.S. (2015). A Review on Hydrological Models. *Aquatic Procedia*. 2015:1001–7.

Douglas-Mankin, K. R., Srinivasan, R., dan Arnold, J. G. (2010). Soil and Water Assessment Tool (SWAT) model: Current developments and applications. *Transactions of the ASABE*. 53(5), 1423-1431.

Duan, Q., Schaake, J., Andressian, V., Franks, S., Goteti, G., dan Gupta, H.V. (2006). Model Parameter Estimation Experiment (MOPEX): An overview of science strategy and major results from the second and third workshop. *Journal of Hydrology*. 320, 3–17.

Dunion, J. P., dan Velden, C.S. (2002). Using the GOES 3.9 micron shortwave channel to track low-level cloud-drift winds. *Proc. of the Sixth Int. Winds Workshop Madison*. WI, WMO, 277–282.

Easton, Z. M., dan Bock, E. (2015). *Hydrology Basics and the Hydrologic Cycle*. Publication BSE-191P.

Edwards, P. J., Williard, K. W., dan Schoonover, J. E. (2015). Fundamentals of Watershed Hydrology. *Journal of Contemporary Water Research & Education*. 154: 3-20.

Efstratiadis, A., dan Koutsoyiannis, D. (2010). One decade of multiobjective calibration approaches in hydrological modelling: a review. *Hydrological Sciences Journal*. 55(1), 58–78.

Engel, B. A., Srinivasan, R., Arnold, J., Rewerts, C., dan Brown, S. J. (1993). Nonpoint source (NPS) pollution modeling using models integrated with geographic information systems (GIS). *Water Science and Technology.* 28(3-5), 685-690.

Fang, H., Beaudoing, H. K., Teng, W. L., dan Vollmer, B. E. (2009). Global Land data assimilation system (GLDAS) products, services and application from NASA hydrology data and information services center (HDISC).

Farr, T. G., Rosen, P. A., Caro, E., Crippen, R., Duren, R., Hensley, S., Kobrick, M., Paller, M., Rodríguez, E., Roth, L., Seal, D., Shaffer, S., Shimada, J., Umland, J., Werner, M., Oskin, M., Burbank, D., dan Alsdorf, D. (2007). The Shuttle Radar Topography Mission. Reviews of Geophysics, 45 RG2004.

Flint, R.W. (2004). The Sustainable Development of Water Resources. *Water Resources Update*. 127,41-51.

Fisher, J. B., Debiase, T. A., Qi, Y., Xu, M., dan Goldstein, A. H. (2005). Evapotranspiration models compared on a Sierra Nevada forest ecosystem. *Environmental Modelling & Software*. 20, 783−796.

Food and Agriculture Organization (WHO/FAO) (2003). Diet nutrition and the prevention of chronic diseases. WHO, Geneve, 4-101.

Fritsch, J.M. (1993). The hydrological effects of clearing tropical rainforest and the implementation of alternative land uses. *IAHS Publ.* 216 , 53-66.

Ganoulis, J. (2009). *Risk Analysis of Water Pollution: Second, Revised and Expanded Edition*. Weinheim :Wiley-VCH Verlag GmbH &Co.

Gassman, P. W., Reyes, M. R., Green, C. H., dan Arnold, J. G. (2007). The Soil and Water Assessment Tool : Historical Development, Application, and Future Research Direction. *Journal of American Society of Agricultural and Biological Engineers.* 50(4), 1211-1250

Gassman, P. W., Arnold, J. J., Srinivasan, R., dan Reyes M. (2010). The Worldwide Use of the SWAT Model : Technological drivers, networking impacts and simulation trends. *Proceedings of 21st Century Watershed Technology : Improving Water Quality and Enviroment.* St Joseph Mich : ASABE

Georgakakos, K. P., Seo, D.J., Gupta, H., Schake, J., dan Butts., M. B., (2004). Characterizing streamflow simulation uncertainty through multimodel ensembles. *Journal of Hydrology*. 298, 222–241.

Ghaffari, G., Keesstra, S., Ghodousi, J., dan Ahmadi, H. (2010). SWAT ‐ simulated hydrological impact of land ‐ use change in the Zanjanrood basin, Northwest Iran. *Hydrological Processes: An International Journal*. 24(7), 892-903.

Gharbia, S. S., Gill, L., Johnston, P., dan Pilla, F. (2016). Multi-GCM ensembles performance for climate projection on a GIS platform. *Modeling Earth Systems and Environment*. 2(2), 102.

Gleick, P.H. (1993). *The World's Water 1998-1999*. Washington D.C.:Island Press.

Gosain, A.K., Mani, A., dan Dwivedi, C. (2009). Hydrological Modelling-Literature Review. *Advances in Fluid Mechanics*. 339, 63-70.

Global Water Partnership (GWP) (2009). A handbook for integrated water resources management in basins.

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

Hashim, M., Reba, N., Nadzri, M., Pour, A., Mahmud, M., Mohd Yusoff, A., Ali, M., Jaw, S., dan Hossain, M. (2016). Satellite-based run-off model for monitoring drought in Peninsular Malaysia. *Remote Sensing*. 8(8), 633.

Hawley, M. E., dan McCuen, R. H. (1982). Water yield estimation in western United States. *Journal of the Irrigation and Drainage Division*. 108(IR1), 25–34.

Hay, L. E., Wilby, R. L., dan Leavesley, G. H. (2000). A comparison of delta change and downscaled GCM scenarios for three mountainous basins in the United States. *Journal of the American Water Resources Association*. 36(2), 387-397.

Hooper, B. P. (2003). Integrated water resources management and river basin governance. *Water Resources Update.* 126,12-20.

Huffman, G. J., Bolvin, D. T., Nelkin, E. J., Wolff, D. B., Adler, R. F., Gu, G., ... dan Stocker, E. F. (2007). The TRMM multisatellite precipitation analysis (TMPA): Quasi-global, multiyear, combined-sensor precipitation estimates at fine scales. *Journal of Hydrometeorology*. 8(1), 38-55.

Huffman, G. J., dan Bolvin, D. T. (2015). *Real-time TRMM multi-satellite precipitation analysis data set documentation*. NASA Tech. Doc.

Hundecha, Y., Ouarda, T.B.M.J., dan Bardossy, A. (2008). Regional estimation of parameters of a rainfall runoff model at ungauged watersheds using the 'spatial' structures of the parameters within a canonical physiographic-climatic space. *Water Resources Research*. 44(1).

Ibrahim, A. B. (1994). Analisis imbangan air di kawasan Muda di Negeri Kedah dan Perlis.

Ingram, H. (2009). Contentious Perspectives on Water Resources. *International Studies Review*. 11, 609–611.

Islam, Z. (2011). *A review on physically based hydrologic modeling*. University of Alberta

Ismail, A.I., Ahmad, S., Hashim, N.M., dan Jani, Y.M. (2017). Kesan penyahhutanan ke atas pola suhu dan kelembapan bandingan di Cameron Highlands, Malaysia: Satu analisis awal (The impact of deforestation on the patterns of temperature and relative humidity in Cameron Highlands, Malaysia: A preliminary analysis). *Geografia-Malaysian Journal of Society and Space*. 7(3).

Ismail, W.R., dan Rahaman, Z.A. (1994). The impact of quarrying activity on suspended sediment concentration and sediment load of Sungai Relau, Pulau Pinang, Malaysia. *Malaysian journal of tropical geography*. 25(1), 45-57.

Ithnin, H. (2008). *Scarcity in Abundance: The Water Resources Challenges in Malaysia*. Inaugral Lecture. Universiti Malaya, Kuala Lumpur.

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

Jeong J, Santhi C, Arnold J.G., Srinivasan R, Pradhan S, dan Flynn K. (2011). Development of algorithms for modeling onsite wastewater systems within SWAT. *Transactions of the ASABE*. 54 (5):1693-704.

JPS (2010). *Review of The National Water Reosurce Study (2000 - 2050) and Formulation of National Water Resources Policy*. Kuala Lumpur,Report.

Justin, J. D. (1914). *Derivation of Run-Off from Rainfall Data*. Vol. LXXVII, ASCE, Reston, VA, 346–363.

Lakshmamma, N.D., Balasubramanian, A., Siddalingamurhy, S., dan Sumithra, S. (2015). Estimation of groundwater recharge studies in Gundal watershed, Gundlupet Taluk, Chamarajanagar District, Karnataka, India using remote sensing and GIS. *International Journal of Current Engineering and Technology*. 5(3), 2138-2148.

Lenderink, G., van Ulden, A., van den Hurk, B., dan Keller, F. (2007). A study on combining global and regional climate model results for generating climate scenarios of temperature and precipitation for the Netherlands. *Climate Dynamics*. 29(2-3), 157-176.

Kato, T., R. Kimura, dan Kamichica, M. (2004). Estimation of evapotranspiration, transpiration ratio and water use efficiency from a sparse canopy using a compartment model. *Agricultural Water Management*. 65, 173-191.

Kavetski, D., Kuczera, G., dan Franks, S.W. (2006). Calibration of conceptual hydrological models revisited:1. Overcoming numerical artefacts. *Journal of Hydrology*. 320, 173–186.

Keizrul, A., dan Mohamed, A. (1998). Water – A Situation Appraisal and Possible Actions at the Community Level. *Seminar on "Local Communities and the Environment II"*, Environmental Protection Society Malaysia, Petaling Jaya, Malaysia.

Kerajaan Negeri Kelantan (1995). *Warta Kerajaan*. Kota Bharu: Kerajaan Negeri Kelantan.

Khatami, S., dan Khazaei, B. (2014). Benefits of GIS application in hydrological modeling: A brief summary. *VATTEN–Journal of Water Management and Research*. 70(1), 41-49.

Kite, G., dan Pietroniro, A. (2000). Remote sensing of surface water. *In Remote sensing in hydrology and water management (217-238)*. Springer, Berlin, Heidelberg.

Krysanova V, dan Wechsung F (2000). *SWIM (Soil water integrated model) – User manual*. 69, Potsdam Institute for Climate Impact Research (PIK), Potsdam.

Krysanova, V., dan Arnold, J.G., (2008). Advances in ecohydrological modeling with SWAT: A review. *Hydrological Sciences Journal*. 53(5): 939-947.

Kite G., dan Pietroniro, A. (2000). *Remote Sensing of Surface Water*. In: Schultz G.A., Engman E.T. (eds) Remote Sensing in Hydrology and Water Management. Springer, Berlin, Heidelberg.

Krenkel, P. A., dan Navotny, V. (1979). *River water quality model construction*. In: Modelling of rivers. Shen hiseh Wen (ed.). John Wily, New York.

Kuraji, K. (1996). *Hydrological characteristics of moist tropical forests*. Bull. Tokyo Univ. For. 95: 93–208.

Lane, S. N., Reid, S. C., Tayefi, V., Yu, D., dan Hardy, R. J. (2007). Interactions between sediment delivery, channel change, climate change and flood risk in a temperate upland environment. *Earth Surface Processes and Landforms*. 32, 429–446.

Lee, G., Yu, W., dan Jung, K. (2013). Catchment-scale soil erosion and sediment yield simulation using a spatially distributed erosion model. *Environmental Earth Sciences.* 70(1), pp.33-47.

Levizzani, V., Alberoni, P.P., Bauer, P., Bottai, L., Buzzi, A., Cattani, E., Cervino, M., Ciotti, P., Costa, M.J., Dietrich,S., Gozzini, B., Khain, A., Kidd, Marzano, F.S., Meneguzzo,F., Migliorini,S., Mugnai,A., Porcù, F., Prodi, F., Rizzi,R., Rosenfeld,D., Schanz, L., Smith, E.A., Tampieri, F., Torricella,F., Turk,F.J., Vicente, G.A., dan Zipoli, G. (2000). Use of the MSG SEVIRI channels in a combined SSM/I, TRMM and geostationary IR method for rapid updates of rainfall, *in Proceedings 1st MSG-RAO Workshop*. ESA SP-452, 63-66.

Long, D., Longuevergne, L., dan Scanlon, B.R. (2014). Uncertainty in evapotranspiration from land surface modeling, remote sensing, and GRACE satellites. *Water Resources Research.* 50(2), pp.1131-1151.

Macdonald, A. (2001). Water Resources in the Twenty-First Century: A Global Challenge. *CIWEMs Presidential Conference*. 23 June 200.Cameron House, Loch Lomond, Scotland.157-161.

Malmer, A. (1992). Water-yield changes after clear-felling tropical rainforest and establishment of forest plantation in Sabah, Malaysia. *Journal of Hydrology*. 134(1-4), 77-94.

Malmer, A. (1996). Hydrological effects and nutrient losses of forest plantation establishment on tropical rainforest land in Sabah, Malaysia. *Journal of Hydrology*. 174, 129-148.

Meinshausen, M., Smith, S. J., Calvin, K., Daniel, J. S., Kainuma, M. L. T., Lamarque, J. F., dan Thomson, A. G. J. M. V. (2011). The RCP greenhouse gas concentrations and their extensions from 1765 to 2300. *Climatic Change*. 109(1-2), 213.

McIntyre, N., Lee, H., Wheater, H., Young, A., dan Wagener, T. (2005). Ensemble predictions of runoff in ungauged catchments. *Water Resources Research*. 41, W12434.

Mdee, O. J. (2015). Spatial distribution of runoff in ungauged catchments in Tanzania. *Water Utility Journal*. 9, 61-70.

Medema, W., dan Jeffrey, P. (2005). IWRM and adaptive management: synergy or conflict. *NeWater Report Series*. 7(5).

Milly, P.C.D., Betancourt, J., Falkenmark, M., Hirsch, R.M., Kundzewicz, Z.W., dan Lettenmaier, D.P.(2008). Stationarity is dead: Whither water management. *Science*. 319, 573–574.

Mitchell, K. E., Lohmann, D., Houser, P. R., Wood, E. F., Schaake, J. C., Robock, A., ... dan Higgins, R. W. (2004). The multi‐institution North American Land Data Assimilation System (NLDAS): Utilizing multiple GCIP products and partners in a continental distributed hydrological modeling system. *Journal of Geophysical Research: Atmospheres*, 109(D7).

Mo, X., Liu, S., Lin, Z., dan Zhao, W.(2004). Simulation the spatial and temporal variation of evapotranspiration in the Lushi Catchment. *Journal of Hydrology*. 285, 125-142.

Mohd Zad, S., Zulkafli, Z., dan Muharram, F. (2018). Satellite Rainfall (TRMM 3B42-V7) Performance Assessment and Adjustment over Pahang River Basin, Malaysia. *Remote Sensing*. 10(3), 388.

Montanari, A., Shoemaker, C. A., dan van de Giesen, N. (2010). Introduction to special section on Uncertainty Assessment in Surface and Subsurface Hydrology: An overview of issues and challenges. *Water Resources Research*. 45.

Morgan (2005). *Soil Erosion and Conservation*, *3rd edn*. Oxford: Longman Blackwell Publishing.

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

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., Van Vuuren, D. P., dan Meehl, G. A. (2010). The next generation of scenarios for climate change research and assessment. *Nature*. 463(7282), 747.

Mu, Q., Heinsch, F. A., Zhao, M., dan Running, S. W. (2007). Development of a global evapotranspiration algorithm based on MODIS and global meteorology data. *Remote sensing of Environment*. 111(4), 519-536.

Muñoz-Villers, L. E., dan McDonnell, J.J. (2013). Land use change effects on runoff generation in a humid tropical montane cloud forest region. *Hydrology and Earth System Sciences.* 17:3543– 3560.

Murray, C.P., dan Bloschl, G. (2011). Hydrological modelling in a changing world. *Progress in Physical Georgraphy*. 35(2), 241-261.

Nash, J. E., dan Sutcliffe, J. V. (1970). River flow forecasting through conceptual models part I—A discussion of principles. *Journal of Hydrology*. 10(3), 282-290.

National Aeronautics and Space Administration (NASA) (2004*). The Orbit Viewer Tutorial, Visualization Software for TRMM*. Develop by the TRMM Science Data and Information System (TSDS) (online) available http//tsds.gsfc.nasa.gov

Nawaz, N. R., dan Adeloye, A. J. (1999). Evaluation of monthly runoff estimated by a rainfall-runoff regression model for reservoir yield assessment. *Hydrological Sciences Journal*. 44(1), 113-134.

Neitsch, S. L., Arnold, J. G., Kiniry, J. R., Williams, J. R., dan King, K. W. (2005). *Soil and water assessment tool theoretical documentation version 2005*. Grassland. Soil and Water Research Laboratory, Agricultural Research Service, Blackland Research Center, Texas Agricultural Experiment Station, Texas.

Neitsch, S.L., Arnold, J.G., Kiniry, J.R., and Williams, J.R. (2011). *Soil and water assessment tool theoretical documentation version 2009*. Texas Water Resources Institute.

NRCS (Natural Resources Conservation Service) (2012). *National Engineering Handbook Hydrology Chapters*. NEH Part 630.

Nyeko-Ogiramoi, P., Ngirane-Katashaya, G., Willems, P., dan Ntegeka, V. (2010). Evaluation and inter-comparison of Global Climate Models' performance over Katonga and Ruizi catchments in Lake Victoria basin. Physics and Chemistry of the Earth, Parts A/B/C, 35(13-14), 618-633.

O'Keeffe, J. H., Kaushal, N., Smakhtin, V., dan Bharati, L. (2012). Assessment of Environmental Flows for the Upper Ganga Basin. Report for WWF India.

Olioso, A., Chauki, H., Courault, D., dan Wigneron, J. P. (1999). Estimation of evapotranspiration and photosynthesis by assimilation of remote sensing data into SVAT models. *Remote Sensing of Environment*. 68(3), 341-356.

Olivera, F., Valenzuela, M., Srinivasan, R., Choi, J., Cho, H., Koka, S., dan Agrawal, A. (2006). ArcGIS-SWAT : A Geodata Model and GIS Interface for SWAT. *Journal American Water Resources Assoc*. 42(2), 295-309.

Ollinger, S.V., Aber, J.D., Federer, C.A., Lovett, G.M., dan Ellis, J. (1995). *Modeling physical and chemical climatic variables across the Northeastern U.S. for a geographic information system*. U.S. Forest Service General Technical Report NE191, Radnor, PA

Ollinger, S.V., Smith, M.L., Martin, M.E., Hallett, R.A., Goodale, C.L., dan Aber, J.D. (2002). Regional variation in foliar chemistry and N cycling among forests of diverse history and composition. *Ecology*. 83(2), 339-355.

Oudin, L., Andreassian. V., Perrin, C., Michel, C., dan Le Moine, N. (2008). Ruangan proximity, physical similarity, regression and ungaged catchments: A comparison of regionalization approaches based on 913 French catchments. *Water Resources Research*. 44, W03413.

Parajka J., Merz R., dan Bloschl, G. (2005). A comparison of regionalisation methods for catchment model parameters. *Hydrology and Earth System Sciences*. 9: 157–171.

Parajka J., Blo¨schl G., dan Merz R. (2007). Regional calibration of catchment models: Potential for ungauged catchments. *Water Resources Research.* 43: W06406.

Peel, M. C., Chiew, F. H. S., Western, A. W., dan McMahon, T. A. (2000). Extension of unimpaired monthly streamflow data and regionalisation of parameter values to estimate streamflow in ungauged catchments. Report prepared for the Australian National Land and Water Resources Audit

Penman, H.L. (1956). Evaporation an Introductory Survey. *Netherlands Journal of Agricultural Science*. 4, 9-29.

Perry, C. (2005). Irrigation reliability and the productivity of water: A proposed methodology using evapotranspiration mapping. *Irrigation and Drainage Systems.* 19(3-4), 211-221.

Pietroniro A., dan Prowse T.D. (2002). Applications of remote sensing in hydrology. *Hydrological Processes*. 16, 1537 – 1541.

Priscoli, J. D. (2013). Keynote address: clothing the IWRM emperor by using collaborative modeling for decision support. *Journal of the American Water Resources Association*. 49(3), 609-613.

Post, J., Habeck, A., Hattermann, F., Krysanova, V., Wechsung, F., dan Suckow, F. (2007). Evaluation of water and nutrient dynamics in soil–crop systems using the eco-hydrological catchment model SWIM. *In Modelling water and nutrient dynamics in soil–crop systems* (pp. 129-146). Springer, Dordrecht.

Prigent, C. (2010). Precipitation retrieval from space: An overview. *Comptes Rendus Geoscience*. 342(4–5), 380–389.

Puskas, C. M., Meertens, C. M., dan Philips, D. (2017). Hydrologic Loading Model Displacements from the National and Global Data Assimilation Systems (NLDAS and GLDAS). Report.

Raghunath, H. M. (1985). *Hydrology, principles, analysis and design*. India: Wiley Eastern Limeted:16-120.

Rahman, H.A. (2009). Global climate change and its effects on human habitat and environment in Malaysia. *Malaysian Journal of Environmental Management*. 10(2), 17-32.

Rahaman, M. M., dan Varis, O. (2005). Integrated water resources management: evolution, prospects and future challenges. *Sustainability: science, practice and policy*. 1(1), 15-21.

Ramlan, M. N. (1999). *Ekologi asas dan alam semula jadi terpilih*. BIROTEKS, Universiti Teknologi MARA.

Rango, A. (1994). Application of remote sensing methods to hydrology and water resources. *Hydrological Sciences Journal*. 39(4), 309-320.

Reichl, J.P.C., Western, A.W., McIntyre, N.R., dan Chiew, F.H.S. (2009). Optimization of a similarity measure for estimating ungauged stream flow. *Water Resources Research*. 45, W010423.

Reuter, H. I., Nelson, A., dan Jarvis, A. (2007). An evaluation of void‐filling interpolation methods for SRTM data. *International Journal of Geographical Information Science*. 21(9), 983-1008.

Rodell, M., Houser, P. R., Jambor, U. E. A., Gottschalck, J., Mitchell, K., Meng, C. J., dan Entin, J. K. (2004). The global land data assimilation system. *Bulletin of the American Meteorological Society*. 85(3), 381-394.

Rothacher, J., (1965). Streamflow from small watersheds on the western slope of the Cascade Range of Oregon. *Water Resources Research*. 1(1), 125-134.

Sakke, N., Ithnin, H., Ibrahim, M. H., dan Hussain, T. P. R. S. (2017). Kemarau hidrologi dan kelestarian sumber air di Malaysia: Kajian analisis sifat Lembangan Langat, Selangor (Hydrological drought and the sustainability of water resources in Malaysia: An analysis of the properties of the Langat Basin, Selangor). *Geografia-Malaysian Journal of Society and Space*. 12(7).

Sandra, G. (2015). *Impact of climatic parameters on watershed management practices using GIS techniques*. Master, Kerala Agricultural University.

Santiago, R.B. (1993). Impact of agroforestry and gully stabilisation on the water budget of a secondary dipterocarp forest watershed, Norzagaray, Bulcan, Philippines. *The technical journal of Philippine ecosystems and natural resources*. 3 (2), pp. 1-26.

Sellers, W. D. (1969). Physical climatology, University of Chicago Press, Chicago, 85–89.

Shaibu, S., Odai, S. N., Adjei, K. A., Osei, E. M., dan Annor, F. O. (2012). Simulation of runoff for the Black Volta Basin using satellite observation data. *International Journal of River Basin Management*. 10(3), 245-254.

Shakirah, J.A., Sidek, L.M., Hidayah, B., Nazirul, M.Z., Jajarmizadeh, M., Ros, F.C., dan Roseli, Z.A. (2016). March. A review on flood events for kelantan river watershed in malaysia for last decade (2001-2010). *In IOP Conference Series: Earth and Environmental Science* .Vol. 32, No. 1, p. 012070. IOP Publishing.

Shamir, E., Imam, B., Morin, E., Gupta, H. V., dan Sorooshian, S. (2005). The role of hydrograph indices in parameter estimation of rainfall–runoff models. Hydrological Processes. *An International Journal*. 19(11), 2187-2207.

Shi, X., Qin, T., Yan, D., Sun, R., Cao, S., Jing, L., Wang, Y., dan Gong, B. (2018). Analysis of the Changes in the Water Yield Coefficient over the Past 50 Years in the Huang-Huai-Hai River Basin, China. *Advances in Meteorology*.

Singh, V. P., dan Fiorentino, M. (2013). *Geographical information systems in hydrology* (Vol. 26). Springer Science & Business Media.

Singh, A. (2018). A Concise Review on Introduction to Hydrological Models. *GRD Journals- Global Research and Development Journal for Engineering*. 3 (10), 14-19.

Sorooshian, S., Hsu, K. L., Coppola, E., Tomassetti, B., Verdecchia, M., dan Visconti, G. (2008). *Hydrological modelling and the water cycle: coupling the atmospheric and hydrological models* (Vol. 63). Springer Science & Business Media.

SPAN (2014). *Laporan Tahunan 2014*. https: //www.span.gov.my/ document/upload/ lskZ9PGf06H5GFFDnyb5Vs7Lyi79abbl.pdf

Srinivasan, R., dan Arnold, J.B. (1994). Integration of a Bain-Scale Water Quality Model with GIS. *Water Resources Bulletin.* 30(3). 453-462.

Strahler, A.N., dan Strahler A. H.(1987). Modern physical geography, 3rdedn.Wiley, New York p 544.

Sun, G., McNulty, S.G., Lu, J., Amatya, D.M., Liang, Y., dan Kolka, R.K. (2005). Regional annual water yield from forest lands and its response to potential deforestation across the southeastern United States. *Journal of Hydrology*. 308(1-4), 258-268.

Tafera, B., dan Stroosnijder, L. (2007). Integrated watershed management: a planning methodology for construction of new dams in Ethiopia. *Lakes & Reservoirs: Research and Management*. 12(4): 247-259.

Tan, M., dan Duan, Z. (2017). Assessment of GPM and TRMM precipitation products over Singapore. *Remote Sensing*. 9(7), 720.

Tan, M. L., Gassman, P. W., Srinivasan, R., Arnold, J. G., dan Yang, X. (2019). A Review of SWAT Studies in Southeast Asia: Applications, Challenges and Future Directions. *Wate*r. 11(5), 914.

Tan, M., Ibrahim, A., Duan, Z., Cracknell, A., dan Chaplot, V. (2015). Evaluation of six high-resolution satellite and ground-based precipitation products over Malaysia. *Remote Sensing*. 7(2), 1504-1528.

Tan, M. L., Ibrahim, A. L., Cracknell, A. P., dan Yusop, Z. (2017). Changes in precipitation extremes over the Kelantan River Basin, Malaysia. *International Journal of Climatology*. 37: 3780-3797.

Tang, F.F., Xu, H.S., dan Xu, Z.X. (2012). Model calibration and uncertainty analysis for runoff in the Chao River Basin using sequential uncertainty fitting. *Procedia Environmental Sciences*. 13: 1760– 1770.

Taye, M. T., Ntegeka, V., Ogiramoi, N. P., dan Willems, P. (2011). Assessment of climate change impact on hydrological extremes in two source regions of the Nile River Basin. *Hydrology and Earth System Sciences*. 15(1), 209-222.

Tapiador, F. J., Kidd, C., Levizzani, V., dan Marzano, F.S. (2004). A neural networks-based PMW-IR fusion technique to derive half hourly rainfall estimates at 0.1° resolution. *Journal of Applied Meteorology*. 43, 576-594.

Theesfeld, I., dan Schleyer, C. (2013). Germany's light version of integrated water resources management. *Environmental Policy and Governance*. 23(2), 130-144.

Timmermans, W. J., dan Meijerink, A. M. J. (1999). Remotely sensed actual evapotranspiration: implications for groundwater management in Botswana. *International Journal of Applied Earth Observation and Geoinformation*. 1(3-4), 222-233.

Todd, M. C., Taylor, R. G., Osborn, T. J., Kingston, D. G., Arnell, N. W., dan Gosling, S. N. (2011). Uncertainty in climate change impacts on basin-scale freshwater resources–preface to the special issue: the QUEST-GSI methodology and synthesis of results. *Hydrology and Earth System Sciences*. 15(3), 1035-1046.

Todini, E. (2007). Hydrological catchment modelling: Past, present and future. *Hydrology and Earth System Sciences*. 11(1), 468–482.

Thornthwaite, C.W. (1948). An approach toward a rational classification of climate (Vol. 66, No. 1, p. 77). LWW.

Trenberth, K.E., dan Asrar, G.R. (2012). Challenges and opportunities in water cycle research: WCRP contributions. In The Earth's Hydrological Cycle (pp. 515-532). Springer, Dordrecht.

Tuppad, P., Douglas-Mankin, K.R., Lee, T., Srinivasan, R., dan Arnold, J.G. (2011). Soil and Water Assessment Tool (SWAT) hydrologic/water quality model: Extended capability and wider adoption. *Transactions of the ASABE*. 54(5), 1677-1684.

UNEP (2002). *Vital Water Graphics. An Overview of the State of the World's Fresh and Marine Waters*.Online: http://www.unep.org/vitalwater

UNESCO (2009). *Introduction to the IWRM Guidelines at River Basin Level*. Paris: UNESCO.

Unit Perancang Ekonomi (2001). Rancangan Malaysia ke Lapan 2001-2005. Kuala-Lumpur: Jabatan Percetakan Negara.

Unit Perancang Ekonomi (2010). Rancangan Malaysia ke Sepuluh 2011-2015. Putrajaya: Jabatan Perdana Menteri.

USDA (2009). United States Summary and State Data. In 2009 Census of Agriculture; Geographic Area Series, Part 51. AC-07-A-51; U.S. Department of Agriculture: Washington, DC, USA, 2009; Volume 1, 739.

Varikoden, H., Preethi, B., Samah, A. A., dan Babu, C. A. (2011). Seasonal variation of rainfall characteristics in different intensity classes over Peninsular Malaysia. *Journal of hydrology*. 404(1-2), 99-108.

Venot, J. P., Bharati, L., Giordano, M., dan Mollé, F. (2011). Beyond water, beyond boundaries: spaces of water management in the Krishna river basin, South India. *The Geographical Journal*. 177(2), 160-170.

Viney, N.R., Bormann, H., Breuer, L., Bronstert, A., Croke, B.F.W., dan Frede, H. (2009). Assessing the impact of land use change on hydrology by ensemble modelling (LUCHEM). 2: Ensemble combinations and predictions. *Advances in Water Resources*. 32, 147–158.

Vogel, R. M., Wilson, I., dan Daly, C. (1999). Regional regression models of annual streamflow for the United States. *Journal of Irrigation and Drainage Engineering*. 125(3), 148–157.

Wagner, W., Verhoest, N., Ludwig, R., dan Tedesco, M. (2009). Editorial remote sensing in hydrological sciences. *Hydrology and Earth System Sciences*. 13(6), 813-817.

Wagener, T.M., Sivapalan, M., Troch, P.A., McGlynn, B.L., Harman, C.J., dan Gupta, H.V. (2010). The future of hydrology: An evolving science for a changing world. *Water Resources Research*. 46, W05301.

Wang, W., Xiao, J. Ollinger, S. V. Desai, A. R. Chen, J., dan Noormets, A. (2014). Quantifying the effects of harvesting on carbon fluxes and stocks in northern temperate forests. *Biogeosciences.* 11, 6667– 6682.

Warner, J. F., Wester, P., dan Hoogesteger, J. (2014). Struggling with scales: revisiting the boundaries of river basin management. Wiley Interdisciplinary Reviews. *Water*. 1(5), 469-481.

Watson, F.G.R. (1999). *Large scale, long term modelling of the effects of land cover change on forest water yield*. PhD thesis, Department of Civil and Environmental Engineering, The University of Melbourne, Australia.

Watson F.G.R., Vertessy R.A., dan Grayson R.B. (2001). Large-scale modelling of forest hydrological processes and their long-term effect on water yield. *Hydrological Processes*. 13, 689-700.

Williams, J.R., Arnold, J.G., Kiniry, J.R., Gassman, P.W., dan Green, C.H. (2008). History of model development at Temple, Texas. *Hydrological Sciences Journal*. 53(5), 948-960.

Wohl, E., Barros, A., Brunsell, N., Chappell, N.A., Coe, M., Giambelluca, T., Goldsmith, S., Harmon, R., Hendrickx, J.M., Juvik, J., dan McDonnell, J. (2012). The hydrology of the humid tropics. *Nature Climate Change*. 2(9), 655.

World Bank (2006). Pakistan Strategic Country Environmental Assessment, Volume II World Bank, Washington, DC.

Xia, Y., J. Sheffield, J., Ek, M.B., Dong, J., Chaney, N., Wei, H., Meng, J., dan Wood, E.F. (2014). Evaluation of multi-model simulated soil moisture in NLDAS-2. *Journal of Hydrology*. 512, 107-125.

Xu, X., Li, J., dan Tolson, B. A. (2014). Progress in integrating remote sensing data and hydrologic modeling. Progress in Physical Geography: *Earth and Environment*. 38(4), 464–498.

Xie, M. (2006). Integrated Water Resources Management (IWRM) – Introduction to Principles and Practices. *Africa Regional Workshop on IWRM*. 29 November 2006. Nairobi World Bank Institut, 1-15.

Yang, Q., Meng, F. R., Zhao, Z., Chow, T. L., Benoy, G., Rees, H. W., dan Bourque, C. P. A. (2008). Assessing the impacts of flow diversion terraces on stream water and sediment yields at a watershed level using SWAT model. *Agriculture, Ecosystems & Environment.* 132(1-2), 23-31.

Yao T., Masson-Delmotte V., Gao J., Yu W., Yang X., Risi C., Sturm C., Werner M., Zhao H., He Y., Ren W., Tian L, Shi C., dan Hou S. (2014). A review of climate controls on delta O-18 in precipitation over the Tibetan Plateau: observations ansecd simulations. Rev. Geophys.

Yates, D., Purkey, D., J. Sieber, A., Huber-Lee, dan Galbraith, H. (2005). WEAP21 A demand, priority and preference driven water planning model. Part 2: Aiding freshwater ecosystem service evaluation. *Water International*. 30, 501–512.

Ye, W., Bates, B. C., Jakeman, A. J., Viney, N. R., dan Sivapalan, M. (1997). Performance of conceptual rainfall-runoff models in low-yielding catchments, *Water Resources Research*. 33, 153–166.

Yusoff, W. A., Jaafar, M., Kamarudin, M. K. A., dan Toriman, M. E. (2015). Kajian penerokaan tanah dan perubahan kualiti air di tanah tinggi Lojing, Kelantan, Malaysia. *Malaysian Journal of Analytical Sciences*. 19(5), 951-959.

Zhang, Y.Q., dan Chiew, F. H. S. (2009). Relative merits of different methods for runoff predictions in ungauged catchments. *Water Resources Research.* 45, W07412

Zhang, H., dan Oweis, T. (1999). Water–yield relations and optimal irrigation scheduling of wheat in the Mediterranean region. *Agricultural Water Management*. 38(3), 195-211.

Zhang, Y., Leuning, R., Chiew, F. H. S., Wang, E., Zhang, L., Liu,C., Sun, F., Peel, M. C., Shen, Y., dan Jung, M. (2012). Decadal trends inevaporation from global energy and water balances. *Journal of Hydrometeorology*. 13, 379–391.

Zhang, Z., Wagener, T., Reed, P., dan Bhushan, R. (2008). Reducing uncertainty in predictions in ungauged basins by combining hydrological indices regionalization and multiobjective optimization. *Water Resources Research*. 44(12).

SENARAI PENERBITAN

1. Ramli, M. H., and Ibrahim, A B. (2018). Remote Sensing-Based Water Yield Estimation of The Kelantan River Basin, Malaysia. *ARPN Journal of Engineering and Applied Sciences*, 13(6), 2292 – 2300
2. Ramli, M. H. B. (2018). Water Yield Estimation in a Tropical Watershed using Remote Sensing and SEBAL Model. *American Scientific Research Journal for Engineering, Technology, and Sciences*, 40(1), 18-26.
3. Tan, M. L., Ramli, H. P., & Tam, T. H. (2018). Effect of DEM Resolution, Source, Resampling Technique and Area Threshold on SWAT Outputs. *Water resources management*, 32(14), 4591-4606.