**UNIVERSITI PUTRA MALAYSIA**

# *DAILY OPERATION OF BUKIT MERAH RESERVOIR WITH STOCHASTIC DYNAMIC PROGRAMMING UNDER CLIMATE CHANGE IMPACT*

**RASHA MOHAMMADSIME FADHIL**

**FK 2018 106**

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By

**RASHA MOHAMMADSIME FADHIL**

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

**May 2018**

# DEDICATION

To

The spirit immortal in my heart and mind forever, scarified person, my late father

My dear mother for her lovely and careful to achieve this dream all respect to her

My brother, sisters and their lovely children,

My best friend and sister Ms. Hiba

My wounded city

Mosul

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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**Chairman : MD, Rowshon Kamal, PhD**
**Faculty : Engineering**

In recent decades, growing populations and economic development in urban regions have resulted in severe water shortage in many countries, whereas around 70% of the total global water is used in agriculture. Anthropogenic climate change is another serious concern, potentially causing water shortages over different spatial and temporal scales. Due to increases in the global mean temperature, changes in the frequency and intensity of precipitation, and rising sea levels. These changes will be having adverse effects on water resources management. Bukit Merah Reservoir (BMR) located in Perak, Malaysia is chosen as a study site to examine future optimal release policies to supply paddy irrigation water to the Kerian Irrigation Scheme (KIS), as well as meeting the domestic and industrial water demand. Kurau River Basin (KRB), where 4 weather stations are located, is considered as the main source of water supply to BMR. This study attempted to optimal reservoir operation with the adaptive future strategies under the new realities of climate change on the hydrological regimes at a tropical agro-hydrological watershed.

Many studies have been conducted on the future change in the hydrological cycle at the global and continental levels over the coming decades using General Circulation Models (GCMs) under different greenhouse gas emission scenarios of Representative Concentration Pathways (RCPs). Climate projections from GCMs require downscaling for use in regional water resources management applications, to convert the variables from coarse resolutions to local or regional scales. In this study, future climate variables are generated through statistical downscaling, stochastic Weather GENerator (WGEN) method used to downscaling current and future rainfall and temperature from 10 GCMs output for the 3 future periods: 2010-2039, 2040-2069 and 2070-2099. The GCMs are driven by 3 of the recent updated RCPs scenarios, namely, RCP4.5, RCP6.0 and RCP8.5. The Richardson-type model was discussed to clarify trends and variations in each GCM and ensembles of the variables in the context of the different RCPs and future periods.

The Soil and Water Assessment Tool (SWAT) hydrologic model is applied to KRB to predict streamflow for both historical (1976-2006) and future (2010-2099) periods by following a rigorous calibration and validation analysis using the Sequential Uncertainty Fitting (SUFI-2) technique. SUFI-2 procedures gave good results in minimizing the differences between observed and predicted flows at the outlet of the KRB. The objective functions, viz. coefficient of determination, ($R^2$), Nash-Sutcliff, (NSE) and Percent Bias, (PBIAS), have been tested and show better correlation and agreement between the observed and predicted streamflows on monthly scale. The impact of climate change on future flows of the KRB is evaluated in the validated SWAT model. There is projected streamflow reduction during the off-season months and increasing trend is projected in the main cropping season, with the exception of June and July months where the streamflow remains low, which could be due to high surface warming in future. The response characteristics of the runoff process in KRB identified by SWAT is used for setting model structures for operation of BMR.

Stochastic Dynamic Programming (SDP) is applied to determine the optimal policies for release discharges from the BMR, under current and future conditions (25 scenarios combinations of 10 GCMs, 3 RCPs and 3 future time periods). In particular, 6 sets of projections representing the upper and lower limits of changes in rainfall are considered. The penalty function is prescribed to minimize the difference between the actual release and demand while avoiding overflows from the irrigation canals and maintaining the BMR water level as close to the normal level as possible. Discounting the penalty is necessary to obtain a one-year periodic optimal policy as the limit of the terminal time $T$ goes to infinity. Two extreme projections of rainfall change with opposite signs have been chosen. Using a realistic value of 0.950 for the discount rate, the optimal policies impose restrictions on the discharge rates to meet domestic demand more often for these two extreme cases than under current conditions. The results show that a striking consequence of the optimal policies for the two precipitation extremes both impose restrictions on supplying the irrigation water, resulting in similar increases in the maximum of the value function. This demonstrates that even if operators follow the optimal operation policy, mitigation measures against climate change and increasing water demands are necessary. As the development of alternative water sources currently seems to be inefficient. However, max penalty function mitigates the maximum deficit (MRI) from 23.4% to 11.6%, SDP is very powerful in suppressing the impact of climate change in term of vulnerability. The promotion of water saving technologies for water users is highly recommended.

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

# OPERASI HARIAN TAKUNGAN BUKIT MERAH DENGAN PENGATURCARAAN DINAMIK STOKASTIK DI BAWAH KESAN PERUBAHAN IKLIM

Oleh

**RASHA MOHAMMADSIME FADHIL**

**Mei 2018**

**Pengerusi : MD, Rowshon Kamal, PhD**
**Fakulti : Kejuruteraan**

Pada dekadterkini, bilanganpenduduk yang semakinmeningkat dan pembangunanekonomi di kawasanbandartelahmengakibatkankekurangan air yang teruk di banyak negara, di mana sekitar 70% daripadajumlahkeseluruhan air global digunakandalampertanian. Perubahan iklim antropogenik adalah satu lagi keprihatinan yang serius, yang berpotensi menyebabkan kekurangan air keatas skala ruang dan temporal yang berbeza. Disebabkan oleh kenaikan suhu purata global, perubahan dalam kekerapan dan intensiti hujan, dan peningkatan paras laut. Perubahan ini akan memberi kesan buruk kepada pengurusan sumber air.Takungan Bukit Merah (BMR) yang terletak di Perak, Malaysia yang dipilih sebagai tapak kajian untuk mengkaji polisi pelepasan optimum masa depan untuk membekalkan pengairan air padi kepada Skim PengairanKerian (KIS), serta memenuhi permintaan air domestik dan perindustrian kawasan Kerian , Daerah Larut, Matang, dan Selama. Kawasan tadahan Sungai Kurau (KRB) terletakny 4 stesen kaji cuaca dianggap sebagai sumber bekalan air utama ke kawasan BMR. Kajian ini mencuba operasi takungan optimum dengan strategi masa depan yang menyesuaikan diri di bawah realiti baru perubahan iklim terhadap rejim hidrologi di kawasan aliran air agro-hidrologi tropika. Banyak kajian telah dilakukan mengenai perubahan iklim pada masa depan dalam kitaran hidrologi di peringkat global dan benua dalam dekad yang akan dating dengan menggunakan model peredaranumum (GCMs) di bawah scenario pelepasan gas rumahkaca yang berbeza (Laluan Konsentrasi Perwakilan; RCPs). Unjuran iklim dari GCM memerlukan pengurangan nilai untuk digunakan dalam aplikasi pengurusan sumber air serantau, iaitu untuk mengubah pembolehubah daripada resolusi kasar ke skala tempatan atau serantau, kerana kelakuan pembolehubah hidrologi penting dari rantau ke rantau. Dalam kajian ini, pembolehubah iklim masa depan dijana melalui penurunan statistik, kaedah Stochastic Weather GENERATOR (WGEN) yang digunakan untuk menurunkan hujan dan suhu semasa dan masa depan dari 10 output GCM untuk 3 masa akan datang: 2010-2039, 2040-2069 dan 2070-2099. GCM dipandu oleh 3 senario RCP terkini, iaitu RCP4.5, RCP6.0 dan RCP8.5. Model jenis Richardson dibincangkan untuk menjelaskan tren dan variasi dalam setiap GCM dan ensembles pembolehubah dalam konteks RCP yang berbeza dan masa depan. Model Hidrologi Alat Penilaian Tanah dan Air (SWAT) telah digunakan untuk KRB untuk meramal aliran air sungai untuk kedua-dua sejarah (1976 -2001) dan masa depan (2010-2099) dengan mengikuti analisis penentukuran dan pengesahan yang ketat dengan menggunakan teknik Ketetapan Ketidakpastian Sequential (SUFI-2). Prosedur SUFI-2 memberi keputusan yang baik dalam pengurangan berbezaan antara aliran air yang dicerap dan dianggarkan di titikkeluar KRB. Fugsi objektif, iait upekalipenentuan ($R^2$), Nash-Sutcliff (NSE dan peratusan bias (PBIAS), telah diuji dan menunjukkn korelasi yang lebih baik dan mencapai sepakat antara aliran sungai yang dicerap dan yang diramalkan bagi sekala bulanan. Kesan perubahan iklim pada aliran masa depan KRB dievaluasi dalam model SWAT yang telah disahkan. Terdapat aliran diunjurkan pada bulan-bulan di luar musim dan trend meningkat dijangka pada musim tanaman utama, kecuali bulan Jun dan Julai di mana aliran aliran masih rendah, yang mungkin disebabkan oleh pemanasan permukaan yang tinggi pada masa akan datang. Ciri-ciri tindak balas bagi proses aliran di KRB yang ditentukan oleh SWAT telah diguna untuk penetapan struktur model untuk pengoperasian BMR.

Pengaturcaraan Dinamik Stokastik (SDP) digunakan untuk menentukan dasar yang optimum untuk melepaskan pelepasan dari BMR, di bawah keadaan semasa dan akan datang (25 senario kombinasi 10 GCM, 3 RCP dan 3 masa masa depan). Secara khususnya, 6 set unjuran yang mewakili limit atas dan bawah bagi perubahan hujan telah dipertimbangkan. Fungsi penalty ditetapkan untuk meminimumkan perbezaan antara pembebasan dan permintaan sebenar sambil mengelakkan limpahan dari terusan pengairan dan mengekalkan paras air BMR yang hamper dengan tahap normal yang mungkin. Mengurangkan penalty adalah perlu untuk mendapatkan polisi optimum berkala selama satu tahun kerana limit masa terminal T pergi tak terhingga. Dua unjuran hujan yang melampau dengan arus bertentangan dipilih. Dengan menggunakan nilai sebenar 0.950 untuk kadar penurunan, polisi optimum mengenakan sekatan terhadap kadar discaj untuk memenuhi keperluan domestik yang lebih kerap untuk kedua-dua kes yang melampau berbanding di bawah keadaan semasa.

Hasilnya menunjukkan bahawa kesan yang ketara terhadap dasar-dasar yang optimum untuk kedua-dua hujan itu melampau kedua-duanya mengenakan sekatan untuk membekalkan air pengairan, menyebabkan peningkatan yang sama dalam maksimum fungsi nilai. Ini menunjukkan bahawa walaupun pengendalian mengikuti polisi pengoperasian optimum, langkah-langkah pengurangan terhadap perubahan iklim dan peningkatan permintaan air diperlukan. Oleh kerana pembangunansumber air alternatif pada masa ininampaknyatidakcekap. Walau bagaimanapun, fungsi maksimum penalti mengurangkan defisit maksimum (MRI) daripada 23.4% hingga 11.6%, SDP sangat berkuasa dalam menekan kesan perubahan iklim dari segi kelemahan. Promosi teknologi penjimatan air untuk penggunaan air sangat disyorkan.

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I certify that a Thesis Examination Committee has met on 31 May 2018 to conduct the final examination of Rasha Mohammadsime Fadhil on her thesis entitled "Daily Operation of Bukit Merah Reservoir with Stochastic Dynamic Programming Under Climate Change Impact" 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.

Members of the Thesis Examination Committee were as follows:

**Hasfalina binti Che Man, PhD**
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

**Rimfiel bin Janius, PhD**
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

**Samsuzana binti Abd Aziz, PhD**
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

**Md. Abdul Mojid, PhD**
Professor
Bangladesh Agricultural University
Bangladesh
(External Examiner)

**RUSLI HAJI ABDULLAH, PhD**
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 30 July 2018

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

**MD, Rowshon Kamal, PhD**
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

**Wayayok Aimrun, PhD**
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

**Ahmad Fikri b. Abdullah, PhD**
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

**Koichi Unami, PhD**
Associate Professor
Graduate School of Agriculture
Kyoto University, Japan
(Member)

**ROBIAH BINTI YUNUS, PhD**
Professor and Dean
School of Graduate Studies
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I hereby confirm that:

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Signature: Kamal
Name of Chairman of Supervisory Committee: Dr. MD, Rowshon Kamal

Signature: w/p Kamal
Name of Member of Supervisory Committee: Dr. Wayayok Aimrun

Signature:
Name of Member of Supervisory Committee: Dr. Ahmad Fikri b. Abdullah

Signature: w/p Kamal
Name of Member of Supervisory Committee: Associate Professor Dr. Koichi Unami

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| | |
|---|---|
| AGCM | Atmospheric General Circulation Model |
| AR5 | Assessment Report five |
| BMR | Bukit Merah Reservoir |
| CDF | cumulative distribution function |
| CMIP3 | Coupled Model Inter-comparison Project 3 |
| CMIP5 | Fifth Coupled Model Intercomparing Project |
| CV | coefficient of variation |
| DD | Dynamic downscaling |
| DDP | Deterministic Dynamic Programming |
| DEM | Digital Elevation Model |
| DID | Drainage and Irrigation Department |
| DOA | Department of Agriculture |
| DP | Dynamic Programming |
| GCM | Global Climate Model |
| GHG | Green House Gase |
| IADA | Integrated Agricultural Development Area |
| IDW | Inverse Distance Weighted |
| KADA | Kemubu Agricultural Development Authority |
| KIS | Kerain irrigation scheme |
| KRB | Kurau River Basin |
| LAM | Limited-Area Model |
| LULC | land use/land cover |
| NEM | NorthEast Monsoon |
| NFSPM | National Food Security Policy in Malaysia |
| NSE | Nash-Sutcliffe Efficiency |
| OGCM | Ocean General Circulation Model |

| | |
|---|---|
| PBIAS | Percent Bias |
| $R^2$ | coefficient of determination |
| RCM | Regional Climate Model |
| RCP | Representative Concentration Pathway |
| RRV | Reliability-Resiliency-Vulnerability |
| SD | Statistical downscaling |
| SDP | Stochastic Dynamic Programming |
| SRES | Special Report on Emission Scenarios |
| SSPS | Shared Socio-economic Pathways |
| SWAT | Soil and Water Assessment Tool |
| SWM | SouthWest Monsoon |
| TAR | Third Assessment Report |
| WEGN | Weather generation |
| WG | Weather generator |
| WMO | World Meteorological Organization |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Water supply is a main key contributing to sustainability of life through satisfying water demand in each sector. At the same time, the most critical issues which the world is facing in the 21st century are the challenges of population growth and climate change impacts. The intensity of increasing demand for water has been evident due to environmental changes, expanding urban and economic development of some countries and the exponential population growth. The world has witnessed a threefold increase in population which, in consequence, increased water withdrawal to more than sixfold (Gude, 2016). This shows that water resources and population growth are uneven throughout the world. It is reported that water demands have already exceeded the supplies in regions with over 40% of the world's population (Bennett, 2000; Sato et al., 2013). Several studies have projected that rising population will increase global crop production to double by 2050 (FAO, 2009; OECD/FAO, 2012).

This arises from the contending need to balance food requirements with the increasing population without compromising the environment which has already been threatened by climate change. It has been reported that a significant increase in mean annual temperature of greater than 2°C will be experienced in many parts of the world by the end of the present century due to the direct impacts of human activities, population growth, and carbon emissions (IPCC, 2007). Boyer et al. (2010) reported that slight disturbances in the amount and frequency of rainfall can significantly impacts on the mean annual river discharge. Also, Christensen et al. (2004) noted that a small change in natural inflows have consequences on reservoir storage. So, developing assessment method of hydrologic regimes is vital to predicting potential impact that climate change has on water resource management.

However, population growth coinciding with climate change causes difficult challenges in fixing sufficient amounts of water demanded for agriculture sector to achieve food security. FAO (2013) highlighted that agricultural sector remains the largest consumer of water. 70% of the global freshwater is currently being used for irrigation purpose. And that irrigation alone accounts for more than 95% of the water supply in some developed countries. The agricultural sector requires increasing the production of food crop and expanding vast land for cultivation to meet the requirements for major staple foods such as rice crop. But, uneven distribution and intensity of rainfall have effects on rice production. More recently, the impact of climate change has been evident in both rainfall and temperature in south-east Asia, Malaysia inclusive (Christensen JH, 2007; IPCC, 2007). The latest 5th Assessment Report (AR5) based on Coupled Model Intercomparing Project Phase 5 (CMIP5) highlights the intensity of rainfall in Peninsular Malaysia increased during the monsoon season in the southwest, and during north-eastern monsoon rains during which the total amount, frequency of extreme rain events and rare intensity of rainfall increased. At the same time, temperatures are expected to rise throughout the region, which will require increased irrigation water needs.

A study on simulation of major rice-growing areas in Asia observed that yield declines by 7% for every 1°C increment in temperature above the observed mean temperature at the time of the investigation (IWRM, 2007). Some investigations indicate the probability of consistent annual rise in temperature between 0.5°C and 1.5°C across Peninsula Malaysia (Tangang et al., 2007). And variation in the regional rainfall patterns which may increase by 10% for the eastern coastal region, while it may drop to 5% in the west coast and southern parts of Peninsula Malaysia (Shaaban et al., 2010; Zakaria et al., 2007). One among recent studies, Tukimat (2017) shows that temperature and rainfall in the intensive irrigated area of Malaysia will increase by 0.2° C and 4% in every ten years, respectively, between 2020 and 2099.

Malaysia is blessed with rainfall throughout the year with an average of 2,420 mm (Alansi, 2010); however, the form in which the supposed changes will impact the country's water resources for rice production in the future is not clear. Disparity in the pattern of rainfall and rise in temperature will affect hydrological system, and, in particular, the runoff volume. Studies in Malaysia, have shown that about 10% reduction in rainfall and increase in temperature by about 1°C during the raining and dry seasons will reduce runoff by 13% to 35% and 14% to 43% correspondingly (MOSTE, 2000). Much works have been done to assess the impact of variation in climatic elements (e.g. temperature, rainfall) and how land use changes have impacted on streamflow for different rivers in different parts of Peninsular Malaysia such as Johor, Pahang rivers and catchment runoff for red hill dam (Ghazvinei et al., 2016; Kamarudin et al., 2015; Tan et al., 2015).

Reservoir plays a vital role in storing water during periods of available surplus (wet season) for use during scarce water availability (dry season) to ensure sustainable crop production. Reservoir performance usually depends on using operational decisions on the release volume during a period. The optimization process involves determining a set of optimal release decisions for consecutive periods of time so that the total expected reward resulting from long-term operations is maximized. Climate change affects meteorological variable that influences on the streamflow, making reservoir inflow indeed variable. Therefore, it is more advantageous to consider future climate variables in reservoir operation.

In Malaysia, few numbers of studies have combined future climate variables for reservoir planning and operation. Tukimat and Harun (2014) proposed approach to enhance the capability and reliability of the reservoir operation for the Pedu-Muda reservoir operations to fit the impact of climate change by utilizing LP and Nondominated Sorting Genetic Algorithm type II (NSGA-II). Tayebiyan et al. (2016) predicted and analyzed changes in future daily rainfall and temperature for 50 years using Long Ashton Research Station Weather Generator (LARS-WG) downscaling produced with the GCMs under three scenarios (B1A, A2 and B1) at Jor Reservoir. Future changes in rainfall and temperature parameters will significantly have influence on water availability and elevation at the reservoir. Ismail et al. (2017) formulated long-term pumping operating rule curves given consideration to uncertainties in climate change, using mixed integer Linear Programming (LP) for Layang reservoir, south of west Malaysia. The study depends on deterministic optimization modeling process using weekly measurements of reservoir inflows to determine the best operational plan using one future GCM model (HadCM3) for one scenario (A2).

However, most natural real-life situations are non-linear, so dealing with real-life scenarios, particularly where high accuracy is a priority, is challenging. For reservoir system optimization, most problems are non-linear, and time-dependent. Therefore, it is difficult to apply LP, with intensive use of computer even. (Hossain & El-Shafie, 2013). The current operation of BMR is based on Standard Operating Policy (SOP), which may not rationalize the release to satisfy the water demand in future. Dynamic programming (DP) should support more robust SOP in reservoir operation, however, the "curse of dimensionality" is the main constraint of DP applied to real world problems. Particularly, when DP is applied to a multi-reservoir system, the problem become more complex with increase in the number of state variables to multi-reservoir operation problems (Bellman and Dreyfus 1962). Deterministic Dynamic programming (DDP) and Stochastic Dynamic programming (SDP) were used in different case studies (Anvari et al., 2017; Karamouz & Houck, 1987; Raje & Mujumdar, 2010; Saadat & Asghari, 2017; Sharma et al., 2016; Jaeeung et al., 2003; Zhang et al., 2013). SDP is an effective optimization model for a single reservoir, with stochastic technique to represent the reality of stochastic variables, such as rainfall as well as state variables compared to the deterministic in representing the natural uncertainty of inflow volume, reservoir storage, and water release downstream (Rani & Moreira, 2010)

## 1.2 Problem statement

Reservoirs are a promising tool to mitigate water scarcity, provided that rational operating techniques are employed to ensure the adequate provision of water for irrigation and other purposes. However, the reservoir operation with current meteorological data is reasonably weak, unless there is a future study for reservoir performance under the impacts of climate change to see how the reservoir be able to meet water demand. The general question posed here is “how we can face the disorders of the future uncertainty of rainfall and temperature, and how to find the optimal operational policies under unknown inflow discharges, while taking the impact of climate change into account?”. In specific issues;

- Achieving water requirement for Agricultural sector and others under climate change is an urgent issue "How and what extent water resources management can solve this issue?". accordingly
- Rainfall and temperature are most important variables in global circulation of water mass and energy under impact of climate change. "Which technique or model is suitable to consider the stochastic nature of rainfall affecting other variables such as local streamflow and then water resources management?"
- A multi-purpose reservoir is operated to meet daily water requirement for irrigation and domestic purposes, ensuring sufficient amount of rice production against growing population. "Which optimization method is applicable for multi-stage reservoir operation adapting the impact of climate change? How does it support daily decision making for reservoir management"?

## 1.3 Justification of the study

As the impact of climate change becomes tangible with the advances in information technology, this study seeks solutions to water management problems in reservoirs in the framework of modelling and optimization. Utilization of the outputs from GCMs with downscaling will deepen our understanding of how the climate change will affect temperature and rainfall patterns at a local level. Physically based models such as SWAT will realize reproduction of holistic hydrological phenomena in computers, contributing to estimation and evaluation of water resources in future. As far as operation of a single reservoir is concerned, SDP will be the most promising approach to the optimal policy because of its firm mathematical foundation. However, integrating the knowledge obtained from the above-mentioned models into SDP will be challenging as a huge computational load is expected if daily or infinitesimal time scale operation is employed. Nevertheless, studying reservoir operation with SDP can be justified; prescribing optimal policy will fully and rationally support decision making of the operator in order to supply water meeting the demand even if the water balance conditions in the reservoir are deteriorating under the impact of climate change.

## 1.4 Aim and objectives of the study

The main aim of this study is to develop optimal daily operation under the new realities of climate change on the hydrological regimes in Bukit Merah reservoir. The specific objectives of the current study are:

1. To generate future hydro-climatological variables of climate change impacts under the RCPs scenario and GCMs using statistical downscaling approach.
2. To estimate the hydrologic parameters ranges and sensitivity analysis for evaluating hydrologic response of an agricultural watershed at the Kurau River Basin (KRB).
3. To develop SDP for optimal reservoir operation policy under climate change impacts.
4. To assess SDP policy in mitigating the impacts of climate change.

## 1.5 Scope of the study

The current study focuses on daily operation of BMR under uncertainty such that the reservoir storage is optimally used for meeting the water demand, considering the impacts of future climate change. Within the scope of the study, the following limitations are highlighted. First, downscaled rainfall and temperature (maximum and minimum) variables are exclusively taken into account during the baseline period and three future periods of 10 GCM projections with 3 RCPs, as other variables (such as relative humidity and wind speed) are less affecting streamflows. Second, the GCM projections are considered separately, and validity of each GCM is not discussed. Advanced implementation of GCMs assimilating real-time observation data would be ideal in a prospective future study. Third, current study is interested in the first order Markov process, which can still deal with the extreme events of rainfall (flood and drought). Fourth, future changes in land use/cover are assumed to be fixed in modeling the runoff process, though land-use change is generally considered one of the main factors influencing the rainfall-runoff relationship. It is believed that changes in land-use in the future will have a similar impact on streamflow. Fifth, SDP policy is calibrated with only for a single year of 2009, because it is noticed that the 2009 rainfall pattern was abnormal in comparison with 12 years observation data at the dam site and with historical record at the nearest observatory.

## 1.6 Thesis organization

The thesis is arranged into the main five chapters, and a brief summary of each chapter has been listed below;

Chapter 1 provides information on the general background which include increasing water demand, population growth and food security. The chapter highlights the problem of how reservoir serves as an alternative source to adapt to the future. The specific objectives of the study and their contribution to water management are also highlighted in this chapter.

Chapter 2 presents the literature reviews specifically on methods, techniques, and approaches used in the study with detailed discussion of the concept of climate change, downscaling techniques and their applications to hydrologic modeling and discusses the optimization techniques related to reservoir operation.

Chapter 3, the methodological illustration starts with background on the study area, followed by data collection and a summary of the methods used to downscale future climate data. Furthermore, it explains the models applied to assessing future streamflow and the process of developing stochastic rainfall and temperature model to determine the optimal use of BMR following SDP technique.

Chapter 4 presents and discusses results of the investigation. These include the impacts of climate change on the future streamflow and on reservoir operation by implementing the SPD to analyze future performance of BMR.

Chapter 5 draws the curtain by presenting the conclusions of the study, its contribution and limitations. The chapter finally closes with suggestions and recommendations for future studies

# REFERENCES

Abaurrea, J., & Asín, J. (2005). Forecasting local daily precipitation patterns in a climate change scenario. Climate Research, 28(3), 183-197.

Abbaspour, K., Johnson, C., & Van Genuchten, M. T. (2004). Estimating uncertain flow and transport parameters using a sequential uncertainty fitting procedure. Vadose Zone Journal, 3(4), 1340-1352.

Abbaspour, K., Yang Jing, Maximov Ivan, Rosi, Bogner Konrad, Mieleitner Johanna, . . . Raghavan, S. (2007). Modelling hydrology and water quality in the pre-alpine/alpine Thur watershed using SWAT. Journal of hydrology, 333(2), 413-430.

Abbaspour, K. C. (2011). SWAT-CUP4: SWAT calibration and uncertainty programs–a user manual. Swiss Federal Institute of Aquatic Science and Technology, Eawag.

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. doi:http://dx.doi.org/10.1016/j.jhydrol.2015.03.027

Abdi, H., & Williams, L. J. (2010). Principal component analysis. Wiley interdisciplinary reviews: computational statistics, 2(4), 433-459. doi:10.1002/wics.101

Afshar, A., Massoumi, F., Afshar, A., & Mariño, M. A. (2015). State of the art review of ant colony optimization applications in water resource management. Water Resources Management, 29(11), 3891-3904. doi:10.1007/s11269-015-1016-9

Ahmad, A., El-Shafie, A., Razali, S. F. M., & Mohamad, Z. S. (2014). Reservoir optimization in water resources: a review. Water Resources Management, 28(11), 3391-3405.

Ahmadi, A. M., Zendehboudi, S., Lohi, A., Elkamel, A., & Chatzis, I. (2013). Reservoir permeability prediction by neural networks combined with hybrid genetic algorithm and particle swarm optimization. Geophysical Prospecting, 61(3), 582-598. doi:10.1111/j.1365-2478.2012.01080.x

Ahmed, I., & Lansey, K. E. (2001). Optimal operation of multi-reservoir systems under uncertainty. Paper presented at the Bridging the Gap: Meeting the World's Water and Environmental Resources Challenges.

Akinbile, C. O., Yusoff, M. S., Talib, S. H. A., Hasan, Z. A., Ismail, W. R., & Sansudin, U. (2013). Qualitative analysis and classification of surface water in

Bukit Merah Reservoir in Malaysia. Water Science and Technology: Water Supply, 13(4), 1138-1145. doi:10.2166/ws.2013.104

Akter, T., & Simonovic, S. P. (2004). Modelling uncertainties in short-term reservoir operation using fuzzy sets and a genetic algorithm/Modélisation d'incertitudes dans la gestion de barrage à court terme grâce à des ensembles flous et à un algorithme génétique. Hydrological sciences journal, 49(6). doi:org/10.1623/hysj.49.6.1081.55722

Alansi, A. W. (2010). Decision Support System for Optimal Design and operation of ponds for watershed runoff management, Unpublished Ph.D thesis, Universiti Putra Malaysia.

Alaya, A. B., Souissi, A., Tarhouni, J., & Ncib, K. (2003). Optimization of Nebhana reservoir water allocation by stochastic dynamic programming. Water Resources Management, 17(4), 259-272.

Ali, M. H. (1999). modeling optimal water management for reservoir based irrigation

projects. Doctor of philosophy in the faculty of engineering, Universiti Putra Malaysia.

Allen, R., & Bridgeman, S. (1986). Dynamic programming in hydropower scheduling. Journal of water resources planning and management, 112(3), 339-353. doi:http://dx.doi.org/10.1061/(ASCE)0733-9496(1986)112:3(339)

Ambak, M., & Jalal, K. (2006). Sustainability issues of reservoir fisheries in Malaysia. Aquatic Ecosystem Health & Management, 9(2), 165-173.

Anghileri, D., Pianosi, F., Soncini-Sessa, R., & Weber, E. (2010). A procedure for the quantitative assessment of water resources management under climate change and the design of adaptation measures.

Anthes, A., Hsie, E.-Y., & Kuo, Y.-H. (1987). Description of the Penn State/NCAR Mesoscale model: version 4 (MM4).

Anvari, S., Mousavi, S., & Morid, S. (2017). Stochastic Dynamic Programming-Based Approach for Optimal Irrigation Scheduling under Restricted Water Availability Conditions. Irrigation and Drainage. doi: 10.1002/ird.2130

Anwar. (2010). Seminar kebangsaan pengurusan tasik dan lembangan: Isu dan status semasa, Kementerian Sumber Asli dan Alam Sekitar, Putrajaya 2010.

Apipattanavis, S., Podestá, G., Rajagopalan, B., & Katz, R. W. (2007). A semiparametric multivariate and multisite weather generator. Water Resources Research, 43(11).

Arnell, N. W., & Delaney, E. K. (2006). Adapting to climate change: public water supply in England and Wales. Climatic change, 78(2), 227-255. doi:org/10.1007/s10584-006-9067-9

Arnold, J. G., Allen, P. M., & Bernhardt, G. (1993). A comprehensive surface-groundwater flow model. Journal of hydrology, 142(1), 47-69. doi:https://doi.org/10.1016/0022-1694(93)90004-S

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

Arnold, J. G., Srinivasan, R., Muttiah, R. S., & Williams, J. R. (1998). Large area hydrologic modeling and assessment part I: Model development1: Wiley Online Library.

Arunkumar, R., & Jothiprakash, V. (2012). Optimal reservoir operation for hydropower generation using non-linear programming model. Journal of The Institution of Engineers (India): Series A, 93(2), 111-120. doi:10.1007/s40030-012-0013-8

Arunkumar, S., & Yeh, W. W.-G. (1973). Probabilistic models in the design and operation of a multi-purpose reservoir system: California Water Resources Center, University of California Davis, California.

Ashofteh, P.-S., Bozorg-Haddad, O., & Loáiciga, H. A. (2017). Development of adaptive strategies for irrigation water demand management under climate change. Journal of Irrigation and Drainage Engineering, 143(2), 04016077.

Ashofteh, P.-S., Haddad, O. B., Akbari-Alashti, H., & Marino, M. A. (2014). Determination of irrigation allocation policy under climate change by genetic programming. Journal of Irrigation and Drainage Engineering, 141(4), 04014059. doi:org/10.1061/(ASCE)IR.1943-4774.0000807

Ashofteh, P.-S., Haddad, O. B., & Loáiciga, H. A. (2015). Evaluation of climatic-change impacts on multiobjective reservoir operation with multiobjective genetic programming. Journal of water resources planning and management, 141(11), 04015030. doi:org/10.1061/(ASCE)WR.1943-5452.0000540

Ayar, P. V., Vrac, M., Bastin, S., Carreau, J., Déqué, M., & Gallardo, C. (2016). Intercomparison of statistical and dynamical downscaling models under the EURO-and MED-CORDEX initiative framework: present climate evaluations. Climate Dynamics, 46(3-4), 1301-1329.

Azamathulla, H., Ghani, A., Zakaria, N. A., & Kiat, C. C. (2009). Linear programming approach for irrigation scheduling–a case study. 14th MANCO, 14, 15.

Banihabib, M. E., Zahraei, A., & Eslamian, S. (2016). Dynamic Programming Model for the System of a Non- Uniform Deficit Irrigation and a Reservoir. Irrigation and Drainage. doi:10.1002/ird.2055

Bárdossy, A. (1997). Downscaling from GCMs to Local Climate through Stochastic Linkages. Journal of environmental management, 49(1), 7-17. doi:http://dx.doi.org/10.1006/jema.1996.0112

Bardossy, A., Duckstein, L., & Bogardi, I. (1995). Fuzzy rule- based classification of atmospheric circulation patterns. International Journal of climatology, 15(10), 1087-1097. doi:10.1002/joc.3370151003

Bárdossy, A., & Pegram, G. (2009). Copula based multisite model for daily precipitation simulation. Hydrology and Earth System Sciences, 13(12), 2299.

Bardossy, A., & Plate, E. J. (1992). Space- time model for daily rainfall using atmospheric circulation patterns. Water Resources Research, 28(5), 1247-1259. doi:10.1029/91WR02589

Barros, M. T., Tsai, F. T., Yang, S.-l., Lopes, J. E., & Yeh, W. W. (2003). Optimization of large-scale hydropower system operations. Journal of water resources planning and management, 129(3), 178-188. doi:org/10.1061/(ASCE)0733-9496(2003)129:3(178)

Bashiri-Atrabi, H., Qaderi, K., Rheinheimer, D. E., & Sharifi, E. (2015). Application of harmony search algorithm to reservoir operation optimization. Water Resources Management, 29(15), 5729-5748. doi:10.1007/s11269-015-1143-3

Bastola, S. (2013). Hydrologic impacts of future climate change on Southeast US watersheds. Regional Environmental Change, 13, 131. doi:10.1007/s10113-013-0454-2

Bates, B. (2008). Climate Change and Water: Technical Paper of the Intergovernmental Panel on Climate Change [7.11 MB]. IPCC Secretariat: Geneva.

Beasley, D., Huggins, L., & Monke, a. (1980). ANSWERS: A model for watershed planning. Transactions of the ASAE, 23(4), 938-0944.

Beersma, J. J., & Buishand, T. A. (2003). Multi-site simulation of daily precipitation and temperature conditional on the atmospheric circulation. Climate Research, 25(2), 121-133.

Bellman, R. (1957). Dynamic Programming Princeton University Press Princeton. New Jersey Google Scholar.

Bennett, A. J. (2000). Environmental consequences of increasing production: some current perspectives. Agriculture, Ecosystems & Environment, 82(1), 89-95. doi:http://dx.doi.org/10.1016/S0167-8809(00)00218-8

Benyahya, L., Caissie, D., St-Hilaire, A., Ouarda, T. B., & Bobée, B. (2007). A review of statistical water temperature models. Canadian Water Resources Journal, 32(3), 179-192.

Bergant, K., & Kajfež-Bogataj, L. (2005). N–PLS regression as empirical downscaling tool in climate change studies. Theoretical and Applied Climatology, 81(1), 11-23.

Bertsekas, D. P. (1998). Network optimization: continuous and discrete models: Athena Scientific Belmont.

Beven, K. (2006). A manifesto for the equifinality thesis. Journal of hydrology, 320(1), 18-36. doi:http://dx.doi.org/10.1016/j.jhydrol.2005.07.007

Beven, K., & Binley, A. (1992). The future of distributed models: model calibration and uncertainty prediction. Hydrological Processes, 6(3), 279-298.

Beven, K., & Freer, J. (2001). Equifinality, data assimilation, and uncertainty estimation in mechanistic modelling of complex environmental systems using the GLUE methodology. Journal of hydrology, 249(1), 11-29.

Bicknell, B. R., Imhoff, J. C., Kittle Jr, J. L., Donigian Jr, A. S., & Johanson, R. C. (1996). Hydrological simulation program-FORTRAN. user's manual for release 11. US EPA.

Biemans, H., Speelman, L., Ludwig, F., Moors, E., Wiltshire, A., Kumar, P., . . . Kabat, P. (2013). Future water resources for food production in five South Asian river basins and potential for adaptation—A modeling study. Science of the Total Environment, 468, S117-S131.

Billa, L., Mansor, S., & Rodzi Mahmud, A. (2004). Spatial information technology in flood early warning systems: an overview of theory, application and latest developments in Malaysia. Disaster Prevention and Management: An International Journal, 13(5), 356-363.

Binger, R., & Theurer, F. (2001). AnnAGNPS technical processes: documentation version 3. Agricultural Research Service, US Department of Agriculture, Oxford, MS.

Bolouri-Yazdeli, Y., Haddad, O. B., Fallah-Mehdipour, E., & Mariño, M. (2014). Evaluation of real-time operation rules in reservoir systems operation. Water Resources Management, 28(3), 715-729. doi:https://doi.org/10.1007/s11269-013-0510-1

Borah, D. K. (2002). Watershed scale nonpoint source pollution models: mathematical bases. Paper presented at the 2002 ASAE Annual Meeting.

Bosa, N., & Liang, P. (1995). Neural Network Fundamentals with Graphs. Algorithms, and Applications.

Boyer, C., Chaumont, D., Chartier, I., & Roy, A. G. (2010). Impact of climate change on the hydrology of St. Lawrence tributaries. Journal of hydrology, 384(1), 65-83. doi:https://doi.org/10.1016/j.jhydrol.2010.01.011

Bras, R., Buchanan, R., & Curry, K. (1983). Real time adaptive closed loop control of reservoirs with the High Aswan Dam as a case study. Water Resources Research, 19(1), 33-52. doi:10.1029/WR019i001p00033

Breinl, K., Turkington, T., & Stowasser, M. (2015). Simulating daily precipitation and temperature: a weather generation framework for assessing hydrometeorological hazards. Meteorological Applications, 22(3), 334-347. doi:10.1002/met.1459

Brekke, L. D., Maurer, E. P., Anderson, J. D., Dettinger, M. D., Townsley, E. S., Harrison, A., & Pruitt, T. (2009). Assessing reservoir operations risk under climate change. Water Resources Research, 45(4). doi:10.1029/2008WR006941

Brigode, P., Oudin, L., & Perrin, C. (2013). Hydrological model parameter instability: A source of additional uncertainty in estimating the hydrological impacts of climate change? Journal of hydrology, 476, 410-425. doi:http://dx.doi.org/10.1016/j.jhydrol.2012.11.012

Buishand, T. A. (1978). Some remarks on the use of daily rainfall models. Journal of hydrology, 36(3), 295-308. doi:http://dx.doi.org/10.1016/0022-1694(78)90150-6

Buishand, T. A., & Brandsma, T. (2001). Multisite simulation of daily precipitation and temperature in the Rhine basin by nearest- neighbor resampling. Water Resources Research, 37(11), 2761-2776. doi:10.1029/2001WR000291

Bürger, G. (1996). Expanded downscaling for generating local weather scenarios. Climate Research, 111-128.

Burt, O. R., & Stauber, M. S. (1971). Economic analysis of irrigation in subhumid climate. American Journal of Agricultural Economics, 53(1), 33-46. doi: https://doi.org/10.2307/3180295

Candela, L., von Igel, W., Javier Elorza, F., & Aronica, G. (2009). Impact assessment of combined climate and management scenarios on groundwater resources and associated wetland (Majorca, Spain). Journal of hydrology, 376(3), 510-527. doi:https://doi.org/10.1016/j.jhydrol.2009.07.057

Carey- Smith, T. S., John Thomson, Peter. (2014). A hidden seasonal switching model for multisite daily rainfall. Water Resources Research, 50(1), 257-272.

Caron, A., Leconte, R., & Brissette, F. (2008). An improved stochastic weather generator for hydrological impact studies. Canadian Water Resources Journal, 33(3), 233-256.

Castelletti, A., Pianosi, F., Soncini- Sessa, R., & Antenucci, J. (2010). A multiobjective response surface approach for improved water quality planning in lakes and reservoirs. Water Resources Research, 46(6). doi:10.1029/2009WR008389

Chamhuri, S., & Quasem, A. A. (2009). The economic dimension of climate change: Vulnerability, impacts on agriculture, poverty and adaptation. Paper presented at the Proceeding of the 2nd National Conference on Agro-Environment.

Chang, F.-J., & Chang, Y.-T. (2006). Adaptive neuro-fuzzy inference system for prediction of water level in reservoir. Advances in Water Resources, 29(1), 1-10. doi:https://doi.org/10.1016/j.advwatres.2005.04.015

Chang, F.-J., Wu, T.-C., Tsai, W.-P., & Herricks, E. E. (2009). Defining the ecological hydrology of Taiwan Rivers using multivariate statistical methods. Journal of hydrology, 376(1–2), 235-242. doi:https://doi.org/10.1016/j.jhydrol.2009.07.034

Chang, F. J., Hui, S. C., & Chen, Y. C. (2002). Reservoir operation using grey fuzzy stochastic dynamic programming. Hydrological Processes, 16(12), 2395-2408. doi:10.1002/hyp.1009

Chapagain, A., & Hoekstra, A. (2011). The blue, green and grey water footprint of rice from production and consumption perspectives. Ecological Economics, 70(4), 749-758.

Chaves, P., & Kojiri, T. (2007). Deriving reservoir operational strategies considering water quantity and quality objectives by stochastic fuzzy neural networks. Advances in Water Resources, 30(5), 1329-1341. doi:http://dx.doi.org/10.1016/j.advwatres.2006.11.011

Che, D., & Mays, L. W. (2015). Development of an optimization/simulation model for real-time flood-control operation of river-reservoirs systems. Water Resources Management, 29(11), 3987-4005. doi:https://doi.org/10.1007/s11269-015-1041-8

Chen, J., & Brissette, F. P. (2014). Comparison of five stochastic weather generators in simulating daily precipitation and temperature for the Loess Plateau of China. International Journal of climatology, 34(10), 3089-3105. doi:10.1002/joc.3896

Chen, J., Brissette, F. P., & Leconte, R. (2011). Uncertainty of downscaling method in

quantifying the impact of climate change on hydrology. Journal of hydrology, 401(3), 190-202. doi:https://doi.org/10.1016/j.jhydrol.2011.02.020

Chen, J., Brissette, F. P., & Leconte, R. (2012). WeaGETS – a Matlab-based daily scale weather generator for generating precipitation and temperature. Procedia Environmental Sciences, 13, 2222-2235. doi:http://dx.doi.org/10.1016/j.proenv.2012.01.211

Chen, J., Zhang, X. c., Liu, W. z., & Li, Z. (2009). Evaluating and extending CLIGEN precipitation generation for the Loess Plateau of China. JAWRA Journal of the American Water Resources Association, 45(2), 378-396. doi:10.1111/j.1752-1688.2008.00296.x

Chen, L., Tan, C.-H., Kao, S.-J., & Wang, T.-S. (2008). Improvement of remote monitoring on water quality in a subtropical reservoir by incorporating grammatical evolution with parallel genetic algorithms into satellite imagery. Water research, 42(1), 296-306. doi:http://dx.doi.org/10.1016/j.watres.2007.07.014

Chen, Y., Chen, X., Xu, C.-Y., & Shao, Q. (2006). Downscaling of daily precipitation with a stochastic weather generator for the subtropical region in South China. Hydrology and Earth System Sciences Discussions, 3(3), 1145-1183.

Cheng, C., Wang, S., Chau, K.-W., & Wu, X. (2014). Parallel discrete differential dynamic programming for multireservoir operation. Environmental Modelling & Software, 57, 152-164. doi:https://doi.org/10.1016/j.envsoft.2014.02.018

Chou, F.-F., & Wu, C.-W. (2014). Determination of cost coefficients of a priority-based water allocation linear programming model–a network flow approach. Hydrology and Earth System Sciences, 18(5), 1857-1872.

Christensen JH, H. B., Busuioc A, Chen A, Gao X, Held I, Jones R, Kolli RK, Kwon WT, Laprise R, Magaña Rueda V, Mearns L, Meńendez CG, Räisänen J, Räisänen J, Rinke A, Sarr A, Whetton P. (2007). Regional climate projections. In Climate Change: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds). Cambridge University Press: Cambridge, UK and New York, NY, USA.

Christensen, N. S., Wood, A. W., Voisin, N., Lettenmaier, D. P., & Palmer, R. N. (2004). The effects of climate change on the hydrology and water resources of the Colorado River basin. Climatic change, 62(1), 337-363. doi:https://doi.org/10.1023/B:CLIM.0000013684.13621.1f

Chu, J. L., Kang, H., Tam, C. Y., Park, C. K., & Chen, C. T. (2008). Seasonal forecast for local precipitation over northern Taiwan using statistical downscaling. Journal of Geophysical Research: Atmospheres, 113(D12). doi:10.1029/2007JD009424

Chu, T., & Shirmohammadi, A. (2004). Evaluation of the SWAT model's hydrology component in the piedmont physiographic region of Maryland. Transactions of the ASAE, 47(4), 1057. doi:10.13031/2013.16579

Chu, W., & Yeh, W. (1978). A NONLINEAR PROGRAMMING ALGORITHM FOR REAL- TIME HOURLY RESERVOIR OPERATIONS. JAWRA Journal of the American Water Resources Association, 14(5), 1048-1063. doi:10.1111/j.1752-1688.1978.tb02245.x

Chun, K. P. (2010). Statistical downscaling of climate model outputs for hydrological extremes.

Combalicer, E., Cruz, R., Lee, S., & Im, S. (2010). Assessing climate change impacts on water balance in the Mount Makiling forest, Philippines. Journal of earth system science, 119(3), 265-283.

Conn, A. R., Gould, G., & Toint, P. L. (2013). LANCELOT: a Fortran package for large-scale nonlinear optimization (Release A) (Vol. 17): Springer Science & Business Media.

Coulibaly, P., Dibike, Y. B., & Anctil, F. (2005). Downscaling precipitation and temperature with temporal neural networks. Journal of Hydrometeorology, 6(4), 483-496. doi:org/10.1175/JHM409.1

Cowpertwait, P. S. (1995). A generalized spatial-temporal model of rainfall based on a clustered point process. Paper presented at the Proceedings of the Royal Society of London A: Mathematical, Physical and Engineering Sciences.

Crawley, P. D., & Dandy, G. C. (1993). Optimal operation of multiple-reservoir system. Journal of water resources planning and management, 119(1), 1-17. doi:org/10.1061/(ASCE)0733-9496(1993)119:1(1)

Davies, T., Cullen, M. J., Malcolm, A. J., Mawson, M., Staniforth, A., White, A., & Wood, N. (2005). A new dynamical core for the Met Office's global and regional modelling of the atmosphere. Quarterly Journal of the Royal Meteorological Society, 131(608), 1759-1782. doi:10.1256/qj.04.101

Dawadi, S., & Ahmad, S. (2012). Changing climatic conditions in the Colorado River Basin: implications for water resources management. Journal of hydrology, 430, 127-141.

De Vos, N., & Rientjes, T. (2005). Constraints of artificial neural networks for rainfall-runoff modelling: trade-offs in hydrological state representation and model evaluation. Hydrology and Earth System Sciences Discussions, 2(1), 365-415.

Deni, S. M., Jamaludin, S. S. S., Zin, W. Z. W., & Jemain, A. A. (2008). Tracing trends in the sequences of dry and wet days over peninsular Malaysia.

Deni, S. M., Jemain, A. A., & Ibrahim, K. (2009). Fitting optimum order of Markov chain models for daily rainfall occurrences in Peninsular Malaysia. Theoretical and Applied Climatology, 97(1-2), 109-121.

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

Desreumaux, Q., Côté, P., & Leconte, R. (2014). Role of hydrologic information in stochastic dynamic programming: a case study of the Kemano hydropower system in British Columbia. Canadian Journal of Civil Engineering, 41(9), 839-844.

Dibike, Y. B., & Coulibaly, P. (2005). Hydrologic impact of climate change in the Saguenay watershed: comparison of downscaling methods and hydrologic models. Journal of hydrology, 307(1), 145-163. doi:http://dx.doi.org/10.1016/j.jhydrol.2004.10.012

Dibike, Y. B., & Coulibaly, P. (2006). Temporal neural networks for downscaling climate variability and extremes. Neural Networks, 19(2), 135-144. doi:http://dx.doi.org/10.1016/j.neunet.2006.01.003

DID. ( 2012). Department of Irrigation and Drainage, Bukit Merah Dam. Accessible at http://www.water.gov.my. Captured on 20 September 2012.

Dile, Y. T., Berndtsson, R., & Setegn, S. G. (2013). Hydrological response to climate change for gilgel abay river, in the lake tana basin-upper blue Nile basin of Ethiopia. PloS one, 8(10), e79296. doi:org/10.1371/journal.pone.0079296

Dong-Kyou, L., Dong-Hyun, C., & Hyun-Suk, K. (2004). Regional climate simulation of the 1998 summer flood over East Asia. Journal of the Meteorological Society of Japan. Ser. II, 82(6), 1735-1753. doi:org/10.2151/jmsj.82.1735

Dor, N., Syafalni, S., Abustan, I., Rahman, M. T. A., Nazri, M. A. A., Mostafa, R., & Mejus, L. (2011). Verification of surface-groundwater connectivity in an irrigation canal using geophysical, water balance and stable isotope approaches. Water Resources Management, 25(11), 2837-2853.

Dorigo, M., & Stützle, T. (2003). The ant colony optimization metaheuristic: Algorithms, applications, and advances Handbook of metaheuristics (pp. 250-285): Springer.

Duan, Q., Sorooshian, S., & Gupta, V. (1992). Effective and efficient global optimization for conceptual rainfall- runoff models. Water Resources Research, 28(4), 1015-1031.

Dubrovský, M., Žalud, Z., & Šťastná, M. (2000). Sensitivity of CERES-Maize yields to statistical structure of daily weather series. Climatic change, 46(4), 447-472.

Eberhart, R. C., Shi, Y., & Kennedy, J. (2001). Swarm intelligence: Elsevier.

Ebrahimpour, M., Balasundram, S., Talib, J., Anuar, A., & Memarian, H. (2011). Accuracy of GeoWEPP in estimating sediment load and runoff from a tropical watershed. Malaysian Journal of Soil Science, 15, 25-33.

Ehsani, N., Vörösmarty, C. J., Fekete, B. M., & Stakhiv, E. Z. (2017). Reservoir Operations Under Climate Change: Storage Capacity Options to Mitigate Risk. Journal of hydrology. doi:https://doi.org/10.1016/j.jhydrol.2017.09.008

El-Shafie, A., El-Shafie, A. H., & Mukhlisin, M. (2014). New approach: integrated risk-stochastic dynamic model for dam and reservoir optimization. Water Resources Management, 28(8), 2093-2107. doi:10.1007/s11269-014-0596-0

Elirehema, S. (2001). Soil water erosion modelling in selected watersheds in Southern Spain.

Engelman, R., Cincotta, R. P., Dye, B., Gardner-Outlaw, T., & Wisnewski, J. (2000). People in the balance. Population and natural resources at the turn of the millennium.

Faber, B. A., & Stedinger, J. R. (2001). SSDP reservoir models using ensemble streamflow prediction (ESP) forecasts. Paper presented at the Bridging the Gap: Meeting the World's Water and Environmental Resources Challenges.

Fadhil, R., Rowshon, M., Ahmad, D., Fikri, A., & Aimrun, W. (2016). A stochastic rainfall generator model for simulation of daily rainfall events in Kurau catchment: model testing. Paper presented at the III International Conference on Agricultural and Food Engineering 1152.

Fadillah, M. N., & Marlia, M. (2016). Malaysian water footprint accounts: Blue and green water footprint of rice cultivation and the impact of water consumption in Malaysia. Paper presented at the AIP Conference Proceedings.

FAO. (2006a). Agriculture Organization,The State of Food and Agriculture, 2006: Food Aid for Food Security? : Food & Agriculture Org.

FAO. (2006b). World agriculture: Towards 2030/2050. Interim report. Prospects for food, nutrition, agriculture and major commodity groups, Alexandratos, Nikos Bruinsma, Jelle Bödeker, G Schmidhuber, J Broca, S Shetty, P Ottaviani, MG.

FAO. (2009). Global agriculture towards 2050. Rome, FAO.

FAO. (2013). Climate-smart agriculture: policies, practices and financing for food security, adaptation and mitigation. Rome. 4.

FAO. (2016). State of Food and Agriculture (SOFA) 2016 - climate change , agriculture and food security, FAO, Rome.

Fatichi, S., Ivanov, V. Y., & Caporali, E. (2011). Simulation of future climate scenarios with a weather generator. Advances in Water Resources, 34(4), 448-467.

Fayaed, S. S., El-Shafie, A., & Jaafar, O. (2013a). Integrated artificial neural network (ANN) and stochastic dynamic programming (SDP) model for optimal release policy. Water Resources Management, 27(10), 3679-3696. doi:10.1007/s11269-013-0373-5

Fayaed, S. S., El-Shafie, A., & Jaafar, O. (2013b). Reservoir-system simulation and optimization techniques. Stochastic Environmental Research and Risk Assessment, 27(7), 1751-1772. doi:10.1007/s00477-013-0711-4

Feng, Z., & Li, P. (2009). Performance-oriented parameter dimension reduction of VLSI circuits. IEEE Transactions on Very Large Scale Integration (VLSI) Systems, 17(1), 137-150.

Firdaus, R. R., Latiff, I. A., & Borkotoky, P. (2013). The impact of climate change towards Malaysian paddy farmers. Journal of Development and Agricultural Economics, 5(2), 57-66.

Fisher, A. J., Green, D. A., Metcalfe, A. V., & Akande, K. (2014). First-passage time criteria for the operation of reservoirs. Journal of hydrology, 519, 1836-1847.

Fletcher, R., Gould, N. I., Leyffer, S., Toint, P. L., & Wächter, A. (2003). Global convergence of a trust-region SQP-filter algorithm for general nonlinear programming. SIAM Journal on Optimization, 13(3), 635-659. doi:org/10.1137/S1052623499357258

Fletcher, R., Leyffer, S., & Toint, P. L. (2002). On the Global Convergence of a Filter--SQP Algorithm. SIAM Journal on Optimization, 13(1), 44-59. doi:org/10.1137/S105262340038081X

Ford, L. (1962). fulkerson, D.: Flows in Networks. Princeton University Press, 412, 527-532.

Fowler, H., & Kilsby, C. (2002). Precipitation and the North Atlantic Oscillation: a study of climatic variability in Northern England. International Journal of climatology, 22(7), 843-866. doi:10.1002/joc.765

Fowler, H., Kilsby, C., & O'Connell, P. (2003). Modeling the impacts of climatic change and variability on the reliability, resilience, and vulnerability of a water resource system. Water Resources Research, 39(8). doi:10.1029/2002WR001778

Fowler, H. J., Blenkinsop, S., & Tebaldi, C. (2007). Linking climate change modelling to impacts studies: recent advances in downscaling techniques for hydrological modelling. International Journal of climatology, 27(12), 1547-1578. doi:10.1002/joc.1556

François, B., Hingray, B., Creutin, J., & Hendrickx, F. (2015). Estimating water system performance under climate change: influence of the management strategy modeling. Water Resources Management, 29(13), 4903-4918.

Gabriel, K., & Neumann, J. (1962). A Markov chain model for daily rainfall occurrence at Tel Aviv. Quarterly Journal of the Royal Meteorological Society, 88(375), 90-95.

Gao, X., Shi, Y., Zhang, D., Wu, J., Giorgi, F., Ji, Z., & Wang, Y. (2012). Uncertainties in monsoon precipitation projections over China: results from two high-resolution RCM simulations. Climate Research, 52, 213-226.

García-Pedrajas, N., Hervás-Martínez, C., & Muñoz-Pérez, J. (2003). COVNET: a cooperative coevolutionary model for evolving artificial neural networks. IEEE Transactions on Neural Networks, 14(3), 575-596. doi:10.1109/TNN.2003.810618

Gassman, P. W., Reyes, M. R., Green, C. H., & Arnold, J. G. (2007). The soil and water assessment tool: historical development, applications, and future research directions. Transactions of the ASABE, 50(4), 1211-1250.

Georgakakos, K. P. (2012). Water Supply and Demand Sensitivities of Linear Programming Solutions to a Water Allocation Problem. Applied Mathematics, 3(10), 1285.

Ghani, A. A., Azamathulla, H. M., Chang, C. K., Zakaria, N. A., & Hasan, Z. A. (2011). Prediction of total bed material load for rivers in Malaysia: A case study of Langat, Muda and Kurau Rivers. Environmental Fluid Mechanics, 11(3), 307-318. doi:10.1007/s10652-010-9177-9

Ghazvinei, P. T., Darvishi, H. H., Hashim, R., Jahromi, S. M., & Aghamohammadi, N. (2016). Assessment of climate change and land use development effects on dam reliability. Hydrology and Earth System Sciences, 2016(1), 1-1.

Ghosh, S., & Misra, C. (2010). Assessing hydrological impacts of climate change: modeling techniques and challenges. The Open Hydrology Journal, 4(1). doi:10.2174/1874378101004010115]

Ghosh, S., & Mujumdar, P. (2007). Nonparametric methods for modeling GCM and scenario uncertainty in drought assessment. Water Resources Research, 43(7). doi:10.1029/2006WR005351

Ghosh, S., & Mujumdar, P. (2008). Statistical downscaling of GCM simulations to streamflow using relevance vector machine. Advances in Water Resources, 31(1), 132-146.

Ghosh, S., Raje, D., & Mujumdar, P. (2010). Mahanadi streamflow: climate change impact assessment and adaptive strategies. CURRENT SCIENCE, 1084-1091.

Gilbert, N., & Troitzsch, K. (2005). Simulation for the social scientist: McGraw-Hill Education (UK).

Giorgi, F., Jones, C., & Asrar, G. R. (2009). Addressing climate information needs at the regional level: the CORDEX framework. World Meteorological Organization (WMO) Bulletin, 58(3), 175.

Gleick, P. H. (2010). Roadmap for sustainable water resources in southwestern North America. Proceedings of the National Academy of Sciences, 107(50), 21300-21305.

Glover, F., & Taillard, E. (1993). A user's guide to tabu search. Annals of operations research, 41(1), 1-28. doi:10.1007/BF02078647

Goh, Y. C., Zainol, Z., & Mat Amin, M. Z. (2016). Assessment of future water availability under the changing climate: case study of Klang River Basin, Malaysia. International Journal of River Basin Management, 14(1), 65-73.

Gosling, S. N., & Arnell, N. W. (2011). Simulating current global river runoff with a global hydrological model: model revisions, validation, and sensitivity analysis. Hydrological Processes, 25(7), 1129-1145. doi:10.1002/hyp.7727

Gould, N. I., Orban, D., & Toint, P. L. (2003). GALAHAD, a library of thread-safe Fortran 90 packages for large-scale nonlinear optimization. ACM Transactions on Mathematical Software (TOMS), 29(4), 353-372. doi:10.1145/962437.962438

Goulter, I., & Tai, F. K. (1985). Practical implications in the use of stochastic dynamic programming for reservoir operation. JAWRA Journal of the American Water Resources Association, 21(1), 65-74.

Grell, G. A., Dudhia, J., & Stauffer, D. R. (1994). A description of the fifth-generation Penn State/NCAR mesoscale model (MM5).

Gu, H., Wang, G., Yu, Z., & Mei, R. (2012). Assessing future climate changes and extreme indicators in east and south Asia using the RegCM4 regional climate model. Climatic change, 114(2), 301-317.

Gude, V. G. (2016). Desalination and sustainability – An appraisal and current perspective. Water research, 89, 87-106. doi:http://dx.doi.org/10.1016/j.watres.2015.11.012

Haan, C. T. (2002). Statistical methods in hydrology: The Iowa State University Press.

Haasnoot, M., Kwakkel, J. H., Walker, W. E., & ter Maat, J. (2013). Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world. Global Environmental Change, 23(2), 485-498. doi:https://doi.org/10.1016/j.gloenvcha.2012.12.006

Haddad, O. B., Afshar, A., & Mariño, M. A. (2006). Honey-bees mating optimization (HBMO) algorithm: a new heuristic approach for water resources optimization. Water Resources Management, 20(5), 661-680. doi: 10.1007/s11269-005-9001-3

Haddad, O. B., Moravej, M., & Loáiciga, H. A. (2014). Application of the water cycle algorithm to the optimal operation of reservoir systems. Journal of Irrigation and Drainage Engineering, 141(5), 04014064. doi:org/10.1061/(ASCE)IR.1943-4774.0000832

Haddeland, I., Heinke, J., Biemans, H., Eisner, S., Flörke, M., Hanasaki, N., . . . Schewe, J. (2014). Global water resources affected by human interventions and climate change. Proceedings of the National Academy of Sciences, 111(9), 3251-3256.

Haguma, D., Leconte, R., Côté, P., Krau, S., & Brissette, F. (2014a). Optimal hydropower generation under climate change conditions for a northern water resources system. Water Resources Management, 28(13), 4631-4644.

Haguma, D., Leconte, R., Krau, S., Côté, P., & Brissette, F. (2014b). Water resources optimization method in the context of climate change. Journal of water resources planning and management, 141(2), 04014051.

Hall, W. A., Butcher, W. S., & Esogbue, A. (1968). Optimization of the Operation of a Multiple- Purpose Reservoir by Dynamic Programming. Water Resources Research, 4(3), 471-477. doi:10.1029/WR004i003p00471

Hamidon, N., Harun, S., Malek, M., Ismail, T., & Alias, N. (2015a). Prediction of paddy irrigation requirements by using statistical downscaling and cropwat models: a case study from the kerian irrigation scheme in malaysia. Jurnal Teknologi, 76(1).

Hamidon, N., Harun, S., Malek, M. A., Ismail, T., & Alias, N. (2015b). Climate Prediction for Upper Kurau River Basin in Perak, Malaysia by using Statistical Downscaling Model.

Hänsel, S., Medeiros, D. M., Matschullat, J., Petta, R. A., & de Mendonça Silva, I. (2016). Assessing Homogeneity and Climate Variability of Temperature and Precipitation Series in the Capitals of North-Eastern Brazil. Frontiers in Earth Science, 4, 29. doi:https://doi.org/10.3389/feart.2016.00029

Hanssen-Bauer, I., & Førland, E. (1998). Long-term trends in precipitation and temperature in the Norwegian Arctic: can they be explained by changes in atmospheric circulation patterns? Climate Research, 10(2), 143-153.

Harrison, P., Dunford, R., Savin, C., Rounsevell, M., Holman, I., Kebede, A., & Stuch, B. (2015). Cross-sectoral impacts of climate change and socio-economic change for multiple, European land-and water-based sectors. Climatic change, 128(3-4), 279-292.

Hasan, Z., Yusoff, M., & Talib, S. (2011). Bukit Merah reservoir sedimentation assessment. Paper presented at the International Conference on Environment Science and Engineering.

Hasan, Z. A., Hamidon, N., Yusof, M. S., & Ab Ghani, A. (2012). Flow and sediment yield simulations for Bukit Merah Reservoir catchment, Malaysia: a case study. Water Science and Technology, 66(10), 2170-2176.

Hashimoto, T., Stedinger, J. R., & Loucks, D. P. (1982). Reliability, resiliency, and vulnerability criteria for water resource system performance evaluation. Water Resources Research, 18(1), 14-20.

Hassan, W. A. W., Kumarenthiran, S., & Kumar, S. M. (2008). Climate Change Scenario and the Impact of Global Warming on the Winter Monsoon. president's message, 6.

Hassan, Z. (2012). Climate Change Impact on Precipitation and Streamflow in a Humid Tropical Watershed. Universiti Teknologi Malaysia.

Hassan, Z., & Harun, S. (2011). Statistical downscaling for climate change scenarios of rainfall and temperature. Proceedings of UMIES, 2011, 12-14.

Hassan, Z., & Harun, S. (2012). Application of statistical downscaling model for long lead rainfall prediction in Kurau River catchment of Malaysia. Malays J Civil Eng, 24(1), 1-12.

Hassan, Z., & Harun, S. (2013). Impact of climate change on rainfall over Kerian, Malaysia with Long Ashton Research Station Weather Generator (LARS-WG). Malays J Civ Eng, 25, 33-44.

Hassan, Z., Harun, S., & Malek, M. A. (2012). Application of ANNs model with the SDSM for the hydrological trend prediction in the sub-catchment of Kurau River, Malaysia. Journal of Environmental Science and Engineering. B, 1(5B).

Hassan, Z., Shamsudin, S., & Harun, S. (2014). Application of SDSM and LARS-WG for simulating and downscaling of rainfall and temperature. Theoretical and Applied Climatology, 116(1-2), 243-257.

Hassan, Z., Shamsudin, S., Harun, S., Malek, M. A., & Hamidon, N. (2015). Suitability of ANN applied as a hydrological model coupled with statistical downscaling model: a case study in the northern area of Peninsular Malaysia. Environmental Earth Sciences, 74(1), 463-477.

Hastings, W. K. (1970). Monte Carlo sampling methods using Markov chains and their applications. Biometrika, 57(1), 97-109.

Hayden, N. G., Potter, K. W., & Liebl, D. S. (2016). Evaluating Infiltration Requirements for New Development Using Extreme Storm Transposition: A

Case Study from Dane County, WI. JAWRA Journal of the American Water Resources Association, 52(5), 1170-1178. doi:10.1111/1752-1688.12441

Heidari, M., Chow, V. T., Kokotović, P. V., & Meredith, D. D. (1971). Discrete differential dynamic programing approach to water resources systems optimization. Water Resources Research, 7(2), 273-282.

Herrera, N. B., Burns, E. R., & Conlon, T. D. (2014). Simulation of groundwater flow

and the interaction of groundwater and surface water in the Willamette Basin and Central Willamette Subbasin, Oregon (2328-0328). Retrieved from

Hertig, E., & Jacobeit, J. (2013). A novel approach to statistical downscaling considering nonstationarities: application to daily precipitation in the Mediterranean area. Journal of Geophysical Research: Atmospheres, 118(2), 520-533. doi:10.1002/jgrd.50112

Hidzrami, S. (2010). Bukit Merah, Perak, Lake Brief. Managing lakes and their basins for sustainable use in Malaysia (Lake Briefs Report Series 1), 29-72.

Hjelmfelt Jr, A. T. (1991). Investigation of curve number procedure. Journal of Hydraulic Engineering, 117(6), 725-737.

Hofierka, J., & Suri, M. (1996). Modelling spatial and temporal changes of soil water erosion. Geograficky casopis slovenskej akademie vied, 48, 255-270.

Holland, J. H. (1975). Adaptation in natural and artificial systems. An introductory analysis with application to biology, control, and artificial intelligence. Ann Arbor, MI: University of Michigan Press.

Hong, S.-Y., Park, H., Cheong, H.-B., Kim, J.-E. E., Koo, M.-S., Jang, J., . . . Chang, E.-C. (2013). The global/regional integrated model system (GRIMs). Asia-Pacific Journal of Atmospheric Sciences, 49(2), 219-243.

Hoogenboom, G. (2000). Contribution of agrometeorology to the simulation of crop production and its applications. Agricultural and Forest Meteorology, 103(1), 137-157. doi:http://dx.doi.org/10.1016/S0168-1923(00)00108-8

Hossain, M. S., & El-Shafie, A. (2013). Intelligent systems in optimizing reservoir operation policy: a review. Water Resources Management, 27(9), 3387-3407.

Huang, W. C., Yuan, L. C., & Lee, C. M. (2002). Linking genetic algorithms with stochastic dynamic programming to the long- term operation of a multireservoir system. Water Resources Research, 38(12). doi:10.1029/2001WR001122

Huth, R. (1999). Statistical downscaling in central Europe: evaluation of methods and potential predictors. Climate Research, 13(2), 91-101.

Huth, R. K., S Metelka, L. (2008). Non- linearity in statistical downscaling: does it bring an improvement for daily temperature in Europe? International Journal of climatology, 28(4), 465-477.

ICOLD. ( 2016). World Register of Dams, accessed 19 March 2016 from http://www.icold- cigb.org/GB/World_register/general_synthesis.asp.

Iglesias, A., Erda, L., & Rosenzweig, C. (1996). Climate change in Asia: a review of the vulnerability and adaptation of crop production. Water, Air, and Soil Pollution, 92(1-2), 13-27. doi:10.1007/BF00175549

IPCC. (2000). Emission Scenarios: A Special Report of IPCC Working Group III. Cambridge Univ. Press, New York.

IPCC. (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.).

Irani, R., & Nasimi, R. (2011). Evolving neural network using real coded genetic algorithm for permeability estimation of the reservoir. Expert Systems with Applications, 38(8), 9862-9866. doi:https://doi.org/10.1016/j.eswa.2011.02.046

Ismail, T., Harun, S., Zainudin, Z. M., Shahid, S., Fadzil, A. B., & Sheikh, U. U. (2017). Development of an optimal reservoir pumping operation for adaptation to climate change. KSCE Journal of Civil Engineering, 21(1), 467-476.

Ismail, W. R., Zullyadini A. Rahaman, Sumayyah Aimi Mohd Najib , & Othman., Z. (2010). Sediment impacts on aquatic ecosystems of the Bukit Merah Reservoir, Perak, Malaysia. IAHS-AISH publication, 258-263.

Isotta, F. A., Frei, C., Weilguni, V., Perčec Tadić, M., Lassegues, P., Rudolf, B., . . . Ratto, S. M. (2014). The climate of daily precipitation in the Alps: development and analysis of a high- resolution grid dataset from pan- Alpine rain- gauge data. International Journal of climatology, 34(5), 1657-1675. doi:10.1002/joc.3794

IWRM. (2007). Roadmapping for Advancing Integrated Water Resources Management (IWRM) Processes. UN-Water, Global Water Partnership (GWP). Retrieved from: https:// www. un.org/ water for life decade/ iwrm. shtml.

Jacob, D., Bärring, L., Christensen, O. B., Christensen, J. H., de Castro, M., Deque, M., . . . Jones, R. (2007). An inter-comparison of regional climate models for Europe: model performance in present-day climate. Climatic change, 81, 31-52.

Jaeeung, Y., Labadie, J. W., & Stitt, S. (2003). Dynamic optimal unit commitment and loading in hydropower systems. Journal of water resources planning and management, 129(5), 388-398.

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(5), 249-261.

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), 316-333. doi:http://dx.doi.org/10.1016/j.jhydrol.2007.01.010

Jones, R., Murphy, J., & Noguer, M. (1995). Simulation of climate change over europe using a nested regional- climate model. I: Assessment of control climate, including sensitivity to location of lateral boundaries. Quarterly Journal of the Royal Meteorological Society, 121(526), 1413-1449. doi:10.1002/qj.49712152610

Jones, R., Noguer, M., Hassell, D., Hudson, D., Wilson, S., Jenkins, G., & Mitchell, J. (2004). Generating high resolution climate change scenarios using PRECIS. Met Office Hadley Centre, Exeter, UK, 35.

Jones, R. N. (2000). Managing uncertainty in climate change projections–issues for impact assessment. Climatic change, 45(3-4), 403-419.

KADA. (2010). (Kemubu Agriculture Development Authority), Annual Report 2010. Ministry of Agriculture and Agro-Based Industry of Malaysia.

Kamarudin, M. K. A., Toriman, M. E., Rosli, M. H., Juahir, H., Aziz, N. A. A., Azid, A., . . . Sulaiman, W. N. A. (2015). Analysis of meander evolution studies on effect from land use and climate change at the upstream reach of the Pahang River, Malaysia. Mitigation and Adaptation Strategies for Global Change, 20(8), 1319-1334.

Kannan, N., Santhi, C., Williams, J., & Arnold, J. (2008). Development of a continuous soil moisture accounting procedure for curve number methodology and its behaviour with different evapotranspiration methods. Hydrological Processes, 22(13), 2114-2121. doi:10.1002/hyp.6811

Karamouz, M., & Houck, M. H. (1982). Annual and monthly reservoir operating rules generated by deterministic optimization. Water Resources Research, 18(5), 1337-1344. doi:10.1029/WR018i005p01337

Karamouz, M., & Houck, M. H. (1987). Comparison of stochastic and deterministic dynamic programming for reservoir operating rule generation. JAWRA Journal of the American Water Resources Association, 23(1), 1-9.

Karamouz, M., Houck, M. H., & Delleur, J. W. (1992). Optimization and simulation of multiple reservoir systems. Journal of water resources planning and management, 118(1), 71-81. doi:org/10.1061/(ASCE)0733-9496(1992)118:1(71)

Karamouz, M., Kerachian, R., & Zahraie, B. (2004). Monthly water resources and irrigation planning: case study of conjunctive use of surface and groundwater resources. Journal of Irrigation and Drainage Engineering, 130(5), 391-402. doi:org/10.1061/(ASCE)0733-9437(2004)130:5(391)

Karamouz, M., & Mousavi, S. J. (2003). Uncertainty based operation of large scale reservoir systems: Dez and Karoon experience. JAWRA Journal of the American Water Resources Association, 39(4), 961-975.

Karim, R. S., Man, A. B., & Sahid, I. B. (2004). Weed problems and their management in rice fields of Malaysia: An overview. Weed Biology and Management, 4(4), 177-186.

Karmarkar, N. (1984). A new polynomial-time algorithm for linear programming. Paper presented at the Proceedings of the sixteenth annual ACM symposium on Theory of computing.

Kasei, R. A. (2010). Modelling impacts of climate change on water resources in the Volta Basin, West Africa: ZEF.

Katz, R. W. (1977). Precipitation as a chain-dependent process. Journal of Applied Meteorology, 16(7), 671-676. doi:org/10.1175/1520-0450(1977)016<0671:PAACDP>2.0.CO;2

Katz, R. W. (1996). Use of conditional stochastic models to generate climate change scenarios. Climatic change, 32(3), 237-255.

Katz, R. W. (2002). Techniques for estimating uncertainty in climate change scenarios and impact studies. Climate Research, 20(2), 167-185.

Katz, R. W., & Zheng, X. (1999). Mixture model for overdispersion of precipitation. Journal of Climate, 12(8), 2528-2537.

Keller, C. F. (2009). Global warming: a review of this mostly settled issue. Stochastic Environmental Research and Risk Assessment, 23(5), 643-676.

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change andFacilitating adaptation. Climatic change, 47(4), 325-352. doi:org/10.1023/A:1005627828199

Kelman, J., Stedinger, J. R., Cooper, L. A., Hsu, E., & Yuan, S. Q. (1990). Sampling stochastic dynamic programming applied to reservoir operation. Water Resources Research, 26(3), 447-454.

Khalid, K., Ali, M., & Rahman, N. A. (2015). The development and application of Malaysian soil taxonomy in SWAT watershed model ISFRAM 2014 (pp. 77-88): Springer.

Khalili, M. (2017). An efficient statistical approach to multi-site downscaling of daily precipitation series in the context of climate change. Climate Dynamics, 49(7-8), 2261-2278. doi:https://doi.org/10.1007/s0038

Khalili, M., Brissette, F., & Leconte, R. (2009). Stochastic multi-site generation of daily weather data. Stochastic Environmental Research and Risk Assessment, 23(6), 837-849.

Khan, M. S., Coulibaly, P., & Dibike, Y. (2006). Uncertainty analysis of statistical downscaling methods. Journal of hydrology, 319(1), 357-382. doi:http://dx.doi.org/10.1016/j.jhydrol.2005.06.035

Kim, R. J., Loucks, D. P., & Stedinger, J. R. (2012). Artificial neural network models of watershed nutrient loading. Water Resources Management, 26(10), 2781-2797. doi:10.1007/s11269-012-0045-x

Kim, Y., Rajagopalan, B., & Lee, G. (2016). Temporal statistical downscaling of precipitation and temperature forecasts using a stochastic weather generator. Advances in Atmospheric Sciences, 33(2), 175-183.

King, L. M., McLeod, A. I., & Simonovic, S. P. (2015). Improved weather generator algorithm for multisite simulation of precipitation and temperature. JAWRA Journal of the American Water Resources Association, 51(5), 1305-1320. doi:10.1111/1752-1688.12307

Kirkpatrick, S., Gelatt, C. D., & Vecchi, M. P. (1983). Optimization by simulated annealing. Science, 220(4598), 671-680.

Kjellström, E., Fowler, H. J., Kendon, E. J., Leung, R., & Truhetz, H. (2014). Taking the next step towards very-high-resolution regional climate modeling. GEWEX News, 24(3), 4-5.

Kleiber, W., Katz, R. W., & Rajagopalan, B. (2012). Daily spatiotemporal precipitation simulation using latent and transformed Gaussian processes. Water Resources Research, 48(1). doi:10.1029/2011WR011105

Klir, G. J., & Folger, T. A. (1988). Fuzzy sets, uncertainty, and information.

Kraus, D., Weller, S., Klatt, S., Santabárbara, I., Haas, E., Wassmann, R., . . . Butterbach-Bahl, K. (2016). How well can we assess impacts of agricultural land management changes on the total greenhouse gas balance (CO 2, CH 4 and N 2 O) of tropical rice-cropping systems with a biogeochemical model? Agriculture, Ecosystems & Environment, 224, 104-115.

Kriegler, E., O'Neill, B. C., Hallegatte, S., Kram, T., Lempert, R. J., Moss, R. H., & Wilbanks, T. (2012). The need for and use of socio-economic scenarios for climate change analysis: A new approach based on shared socio-economic pathways. Global Environmental Change, 22(4), 807-822. doi:http://dx.doi.org/10.1016/j.gloenvcha.2012.05.005

Kuczera, G., & Parent, E. (1998). Monte Carlo assessment of parameter uncertainty in conceptual catchment models: the Metropolis algorithm. Journal of hydrology, 211(1), 69-85.

Kumar, D. N., & Baliarsingh, F. (2003). Folded dynamic programming for optimal operation of multireservoir system. Water Resources Management, 17(5), 337-353. doi:10.1023/A:1025894500491

Kumar, K. R., Sahai, A., Kumar, K. K., Patwardhan, S., Mishra, P., Revadekar, J., . . . Pant, G. (2006). High-resolution climate change scenarios for India for the 21st century. CURRENT SCIENCE, 90(3), 334-345.

Labadie. (2003). Generalized dynamic programming package: CSUDP. Documentation and user guide, version 2.44. Department of Civil Engineering, Colorado State University, Fort Collins.

Labadie, J. (1993). Combining simulation and optimization in river basin management Stochastic hydrology and its use in water resources systems simulation and optimization (pp. 345-371): Springer.

Labadie, J. W. (2004). Optimal operation of multireservoir systems: state-of-the-art review. Journal of water resources planning and management, 130(2), 93-111. doi:http://dx.doi/org/10.1061/(ASCE)0733-9496(2004)130:2(93)

Lai, S. H., & Arniza, F. (2011). Application of SWAT Hydrological Model to Upper Bernam River Basin (UBRB), Malaysia. IUP Journal of Environmental Sciences, 5(2).

Lamb, H. H. (2013). Climate: Present, Past and Future (Routledge Revivals): Volume 1: Fundamentals and Climate Now (Vol. 1): Routledge.

Lane, L. J. (1983). Chapter 19: Transmission Losses. p. 19-1, 19-21. In Soil Conservation Service. : U.S. Goernment Printing Office, Washington, D.C.

Lauri, H., Moel, H. d., Ward, P., Räsänen, T., Keskinen, M., & Kummu, M. (2012). Future changes in Mekong River hydrology: impact of climate change and reservoir operation on discharge.

Le Loh, J., Tangang, F., Juneng, L., Hein, D., & Lee, D.-I. (2016). Projected rainfall

and temperature changes over Malaysia at the end of the 21st century based on PRECIS modelling system. Asia-Pacific Journal of Atmospheric Sciences, 52(2), 191-208.

Leahy, K. (2000). Multicollinearity: When the solution is the problem. Data mining cookbook, 106-108.

Lee, E., & Waziruddin, S. (1970). Applying gradient projection and conjugate gradient to the optimum operation of reservoirs. JAWRA Journal of the American Water Resources Association, 6(5), 713-724. doi:10.1111/j.1752-1688.1970.tb01616.x

Lee, H. S., Trihamdani, A. R., Kubota, T., Iizuka, S., & Phuong, T. T. T. (2017). Impacts of land use changes from the Hanoi Master Plan 2030 on urban heat islands: Part 2. Influence of global warming. Sustainable Cities and Society, 31, 95-108.

Lee, T. S., Haque, M. A., & Najim, M. M. M. (2005). Scheduling the cropping calendar in wet-seeded rice schemes in Malaysia. Agricultural water management, 71(1), 71-84. doi:http://dx.doi.org/10.1016/j.agwat.2004.06.007

Lee, Y., Kim, S.-K., & Ko, I. H. (2006). Two-stage stochastic linear programming model for coordinated multi-reservoir operation Operating Reservoirs in Changing Conditions (pp. 400-410).

Lee, Y. H., Cho, M. K., Kim, S. J., & Kim, Y. B. (2002). Supply chain simulation with discrete–continuous combined modeling. Computers & Industrial Engineering, 43(1), 375-392. doi:http://dx.doi.org/10.1016/S0360-8352(02)00080-3

Leggett, J., Pepper, W. J., Swart, R. J., Edmonds, J., Meira Filho, L., Mintzer, I., & Wang, M. (1992). Emissions scenarios for the IPCC: an update. Climate change, 69-95.

Li, C., Singh, V. P., & Mishra, A. K. (2012). Simulation of the entire range of daily precipitation using a hybrid probability distribution. Water Resources Research, 48(3).

Li, C., Zhou, J., Ouyang, S., Ding, X., & Chen, L. (2014). Improved decomposition–coordination and discrete differential dynamic programming for optimization of large-scale hydropower system. Energy Conversion and Management, 84, 363-373. doi:org/10.1016/j.enconman.2014.04.065

Li, Z., & Fang, H. (2016). Impacts of climate change on water erosion: A review. Earth-Science Reviews, 163, 94-117.

Lind, P., Lindstedt, D., Kjellström, E., & Jones, C. (2016). Spatial and Temporal Characteristics of Summer Precipitation over Central Europe in a Suite of High-Resolution Climate Models. Journal of Climate, 29(10), 3501-3518. doi: http://dx.doi.org/10.1175/JCLI-D-15-0463.1

Lo, J. C. F., Yang, Z. L., & Pielke, R. A. (2008). Assessment of three dynamical climate downscaling methods using the Weather Research and Forecasting

(WRF) model. Journal of Geophysical Research: Atmospheres, 113(D9). doi: 10.1029/2007JD009216

Loftis, J. C., & Houghtalen, R. J. (1987). Optimizing temporal water allocation by irrigation ditch companies. Trans. ASAE, 30(4), 1075-1082.

Loo, Y. Y., Billa, L., & Singh, A. (2015). Effect of climate change on seasonal monsoon in Asia and its impact on the variability of monsoon rainfall in Southeast Asia. Geoscience Frontiers, 6(6), 817-823.

Loucks, D. P., Stedinger, J. R., & Haith, D. A. (1981). Water resource systems planning and analysis: Prentice-Hall.

Loucks, D. P., Van Beek, E., Stedinger, J. R., Dijkman, J. P., & Villars, M. T. (2005). Water resources systems planning and management: an introduction to methods, models and applications: Paris: Unesco.

Lu, B., Li, K., Zhang, H., Wang, W., & Gu, H. (2013). Study on the optimal hydropower generation of Zhelin reservoir. Journal of Hydro-environment Research, 7(4), 270-278. doi:http://dx.doi.org/10.1016/j.jher.2013.01.002

Lupo, A., & Kininmonth, W. (2006). Global Climate Models and Their Limitations.

Mabaya, G., Unami, K., & Fujihara, M. (2017). Stochastic optimal control of agrochemical pollutant loads in reservoirs for irrigation. Journal of Cleaner Production, 146, 37-46.

Maceira, M., & Damázio, J. (2006). Use of the PAR (p) model in the stochastic dual dynamic programming optimization scheme used in the operation planning of the Brazilian hydropower system. Probability in the Engineering and Informational Sciences, 20(1), 143-156. doi: https://doi.org/10.1017/S0269964806060098

Mack, A., Choffnes, E. R., Hamburg, M. A., & Relman, D. A. (2008). Global climate change and extreme weather events: Understanding the contributions to infectious disease emergence: Workshop summary: National Academies Press.

Magadza, C. H. D. (2000). Climate change impacts and human settlements in Africa: prospects for adaptation. Environmental monitoring and assessment, 61(1), 193-205. doi:https://doi.org/10.1023/A:1006355210516

Mahmudul, M., Talib, B., Siwar, C., & Toriman, M. (2010). The impacts of climate change on paddy production in Malaysia: case of paddy farming in North-West Selangor. Paper presented at the Proceedings of the international conference of the 4th International Malaysia-Thailand Conference on South Asian Studies. National University of Malaysia, Malaysia, Mar.

Maier, H. R., & Dandy, G. C. (2000). Neural networks for the prediction and forecasting of water resources variables: a review of modelling issues and applications. Environmental Modelling & Software, 15(1), 101-124. doi:https://doi.org/10.1016/S1364-8152(99)00007-9

Malaysia. (2010). Tenth Malaysia Plan 2011-2015. The Economic Planning Unit, Prime Minister Department, Putrajaya, Malaysia.

Malaysia, A. S. (2010). Managing lakes and their basins for sustainable use in Malaysia. (Lake Briefs Report Series I). Kuala Lumpur: Akademi Sains Malaysia.

Mandal, S., Srivastav, R. K., & Simonovic, S. P. (2016). Use of beta regression for statistical downscaling of precipitation in the Campbell River basin, British Columbia, Canada. Journal of hydrology, 538, 49-62. doi:http://dx.doi.org/10.1016/j.jhydrol.2016.04.009

Mankin, K. R., Koelliker, J., & Kalita, P. (1999). Watershed and lake water quality assessment: An integrated modeling approach. JAWRA Journal of the American Water Resources Association, 35(5), 1069-1080. doi:10.1111/j.1752-1688.1999.tb04194.x

Maraun, D., Wetterhall, F., Ireson, A., Chandler, R., Kendon, E., Widmann, M., . . . Themeßl, M. (2010). Precipitation downscaling under climate change: Recent developments to bridge the gap between dynamical models and the end user. Reviews of Geophysics, 48(3). doi:10.1029/2009RG000314

Mateus, M. C., & Tullos, D. (2016). Reliability, Sensitivity, and Vulnerability of Reservoir Operations under Climate Change. Journal of water resources planning and management, 143(4), 04016085. doi:org/10.1061/(ASCE)WR.1943- 5452.0000742

Mathlouthi, M., & Lebdi, F. (2009). Use of generated time series of dry events for the optimization of small reservoir operation. Hydrological sciences journal, 54(5), 841-851. doi:10.1623/hysj.54.5.841

Matte, D., Laprise, R., & Thériault, J. M. (2016). Comparison between high-resolution climate simulations using single-and double-nesting approaches within the Big-Brother experimental protocol. Climate Dynamics, 47(12), 3613-3626.

McCall, J. (2005). Genetic algorithms for modelling and optimisation. Journal of Computational and Applied Mathematics, 184(1), 205-222. doi:https://doi.org/10.1016/j.cam.2004.07.034

McCuen, R. H. (1982). A guide to hydrologic analysis using SCS methods: Prentice-Hall, Inc.

McDonald, R. I., Weber, K., Padowski, J., Flörke, M., Schneider, C., Green, P. A., . . . Balk, D. (2014). Water on an urban planet: Urbanization and the reach of urban water infrastructure. Global Environmental Change, 27, 96-105.

McMahon, T. A., & Adeloye, A. J. (2005). Water resources yield: Water Resources Publication.

McMahon, T. A., Adeloye, A. J., & Zhou, S.-L. (2006). Understanding performance measures of reservoirs. Journal of hydrology, 324(1), 359-382.

McMillan, H., Jackson, B., Clark, M., Kavetski, D., & Woods, R. (2011). Rainfall uncertainty in hydrological modelling: An evaluation of multiplicative error models. Journal of hydrology, 400(1), 83-94.

Mehrotra, R., & Sharma, A. (2007). A semi-parametric model for stochastic generation of multi-site daily rainfall exhibiting low-frequency variability. Journal of hydrology, 335(1), 180-193. doi:https://doi.org/10.1016/j.jhydrol.2006.11.011

Meinshausen, M., Smith, S. J., Calvin, K., Daniel, J. S., Kainuma, M. L., Lamarque, J., . . . Riahi, K. (2011). The RCP greenhouse gas concentrations and their extensions from 1765 to 2300. Climatic change, 109(1), 213-241. doi:10.1007/s10584-011-0156-z

Mereu, S., Sušnik, J., Trabucco, A., Daccache, A., Vamvakeridou-Lyroudia, L., Renoldi, S., . . . Assimacopoulos, D. (2016). Operational resilience of reservoirs to climate change, agricultural demand, and tourism: A case study from Sardinia. Science of the Total Environment, 543, 1028-1038.

Metternicht, G. (2001). Assessing temporal and spatial changes of salinity using fuzzy logic, remote sensing and GIS. Foundations of an expert system. Ecological modelling, 144(2), 163-179.

Minville, M. (2008). Potentiel d'adaptation aux changements climatiques de la gestion d'un système hydrique exploité pour la production hydroélectrique: étude de la rivière Péribonka (Québec, Canada). École de technologie supérieure.

Mishra, S. K., & Singh, V. P. (2013). Soil conservation service curve number (SCS-CN) methodology (Vol. 42): Springer Science & Business Media.

MITI. (2015). Malaysia International Trade and Industry, 2014 Malaysia International Trade and Industry (MITI). . (2015). MITI Report 2014. Malaysia.

MMD. (2009). Climate Change Scenarios for Malaysia Scientific Report 2001e2099: Numerical Weather Prediction Development Section Technical Development Division. Malaysian Meteorological Department Ministry of Science: Technology and Innovation Kuala Lumpur.

MMD. (2010 ). Daily rainfall amount as recorded at Butterworth Meteorological Station from 2009 to April 2010, Monthly Weather Bulletin Malaysian Meteorological Department, Malaysia. .

MOA. (2011). National Agro-Food Policy 2011-2020. Division of International and Strategic Planning. Putrajaya, Malaysia, ISBN: 978-983-9863-41-3.

Mohammadi, H. G., Gaillardon, P.-E., & De Micheli, G. (2016). Efficient statistical parameter selection for nonlinear modeling of process/performance variation. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, 35(12), 1995-2007.

Mohd Shafiq, Z., Ruddin, A. S., Sah, M., Zarul, H. H., Khaled, P., Syaiful, M., . . . Omar, W. (2014). The effect of seasonal changes on freshwater fish assemblages and environmental factors in Bukit Merah Reservoir (Malaysia). Transylvanian Review of Systematical and Ecological Research, 16(1), 97-108.

Mohseni, O., & Stefan, H. (1999). Stream temperature/air temperature relationship: a physical interpretation. Journal of hydrology, 218(3), 128-141.

Mokhtar, S. A., Ishak, W. H. W., & Norwawi, N. M. (2014). Modelling of reservoir water release decision using neural network and temporal pattern of reservoir water level. Paper presented at the Intelligent Systems, Modelling and Simulation (ISMS), 2014 5th International Conference on.

Moradi-Jalal, M., Bozorg Haddad, O., Karney, B. W., & Mariño, M. A. (2007). Reservoir operation in assigning optimal multi-crop irrigation areas. Agricultural water management, 90(1), 149-159. doi:http://dx.doi.org/10.1016/j.agwat.2007.02.013

Moravej, M., & Hosseini-Moghari, S.-M. (2016). Large Scale Reservoirs System Operation Optimization: the Interior Search Algorithm (ISA) Approach. Water Resources Management, 30(10), 3389-3407. doi:org/10.1007/s11269-016-1358-y

Moriasi, D. N., Gitau, M. W., Pai, N., & Daggupati, P. (2015). Hydrologic and water quality models: Performance measures and evaluation criteria. Transactions of the ASABE, 58(6), 1763-1785.

Morris, K. I., Chan, A., Morris, K. J. K., Ooi, M. C. G., Oozeer, M. Y., Abakr, Y. A., . . . Mohammed, I. Y. (2017). Urbanisation and urban climate of a tropical conurbation, Klang Valley, Malaysia. Urban Climate, 19, 54-71. doi:https://doi.org/10.1016/j.uclim.2016.12.002

MOSTE. (2000). “Initial National Communication (INC) to the United Nations framework convention on climate change (UNFCCC).”, Ministry of Science, Technology and Environment, Malaysia.

Mote, P. W., & Salathe, E. P. (2010). Future climate in the Pacific Northwest. Climatic change, 102(1-2), 29-50. doi:org/10.1007/s10584-010-9848-z

Mousavi, S. J., Karamouz, M., & Menhadj, M. B. (2004a). Fuzzy-state stochastic dynamic programming for reservoir operation. Journal of water resources planning and management, 130(6), 460-470.

Mousavi, S. J., Moghaddam;, K. S., & Seifi, A. (2004b). Application of an Interior-Point Algorithm For Optimization of a Large-Scale Reservoir System. Water Resources Management, 18(6), 519-540. doi:org/10.1007/s11269-004-1075-9

Mujumdar, P., & Ghosh, S. (2008). Climate change impact on hydrology and water resources. ISH Journal of Hydraulic Engineering, 14(3), 1-17.

Mujumdar, P., & Saxena, P. (2004). A stochastic dynamic programming model for stream water quality management. Sadhana, 29(5), 477-497.

Murtagh, B., & Saunders, M. (1998). MINOS 5.5 User's Guide., Standford University Systems Optimization Laboratory. Retrieved from

Nadarajah, S. (2014). Approximate dynamic programming for commodity and energy merchant operations.

Nagesh Kumar, D., Baliarsingh, F., & Srinivasa Raju, K. (2010). Optimal reservoir operation for flood control using folded dynamic programming. Water Resources Management, 24(6), 1045-1064. doi:10.1007/s11269-009-9485-3

NAHRIM. (2006). Study of the impact of climate change on the hydrologic regime and water resources of Peninsular Malaysia. In p. Final Report Ministry of Natural Resources and Environment (Ed.).

NAHRIM. (2011). National Hydraulic Research Institute of Malaysia,http://nahrim.gov.my/index.php/en/servis/58

NAHRIM. (2014). Final Report on extension of the study of the impact of climate change on the hydrologic regime and water resources of Peninsular Malaysia. California Hydrologic Research Laboratory, 526 Isla Place, Davis, California 95616.

Nakicenovic, N., Alcamo, J., Grubler, A., Riahi, K., Roehrl, R., Rogner, H.-H., & Victor, N. (2000). Special Report on Emissions Scenarios (SRES), A Special Report of Working Group III of the Intergovernmental Panel on Climate Change: Cambridge University Press.

Nakicenovic, N., & Swart, R. (2000). Emissions scenarios. A special report of IPCC Working Group III. Pacific Northwest National Laboratory, Richland, WA (US), Environmental Molecular Sciences Laboratory (US).

Nam, W.-H., Choi, J.-Y., & Hong, E.-M. (2015). Irrigation vulnerability assessment on agricultural water supply risk for adaptive management of climate change in South Korea. Agricultural water management, 152, 173-187.

Nandakumar, N., & Mein, R. G. (1997). Uncertainty in rainfall—runoff model simulations and the implications for predicting the hydrologic effects of land-use change. Journal of hydrology, 192(1), 211-232.

Nandalal, K., & Bogardi, J. J. (2007). Dynamic programming based operation of reservoirs: applicability and limits: Cambridge university press.

Narsimlu, B., Gosain, A. K., Chahar, B. R., Singh, S. K., & Srivastava, P. K. (2015). SWAT model calibration and uncertainty analysis for streamflow prediction in the Kunwari River Basin, India, using sequential uncertainty fitting. Environmental Processes, 2(1), 79-95.

Nation, U. (2004). World Population Prospects 2300.Department of Economic and Social Welfares: Population Division. . United Nation, New York.

Neitsch, S., Arnold, J. G., Kiniry, J. R., Srinivasan, R., & Williams, J. R. (2010). Soil and Water Assessment Tool Input Output File Documentation Version 2009. Texas Water Resources Institute Technical Report, 365.

Neitsch, S. L., Arnold, J. G., Kiniry, J. R., & Williams, J. R. (2011). Soil and water assessment tool theoretical documentation version 2009. Retrieved from

New, M., & Hulme, M. (2000). Representing uncertainty in climate change scenarios: a Monte-Carlo approach. Integrated assessment, 1(3), 203-213.

Ng, J. L., Aziz, S. A., Huang, Y. F., Wayayok, A., & Rowshon, M. (2017). Stochastic modelling of seasonal and yearly rainfalls with low-frequency variability. Stochastic Environmental Research and Risk Assessment,Springer Berlin Heidelberg, 31: 2215(1436-3240), 1-19. doi:org/10.1007/s00477-016-1373-9

Nicks, A., Lane, L., & Gander, G. (1995). Weather generator. USDA-Water Erosion Prediction Project hillslope profile and watershed model documentation. NSERL Report(10), 2.1-2.22.

NOAA. (2012). National Oceanic and Atmospheric Administration, 2012. U.S. and Global Precipitation. Retrieved March 2, 2013 . Seattle, Washington.

Noory, H., Liaghat, A. M., Parsinejad, M., & Haddad, O. B. (2011). Optimizing irrigation water allocation and multicrop planning using discrete PSO algorithm. Journal of Irrigation and Drainage Engineering, 138(5), 437-444.

Nüsser, M., & Baghel, R. (2017). 20. The emergence of technological hydroscapes in the Anthropocene: socio-hydrology and development paradigms of large dams. Handbook on Geographies of Technology, 287.

OECD/FAO. (2012). OECD-FAO Agricultural Outlook 2012-2021, OECD Publishing and FAO. Available:.

Oishi, S. (2017). Optimization of Integrated Operation of Dams Using Ensemble Prediction Sustainable Water Resources Planning and Management Under Climate Change (pp. 133-154): Springer.

Ojha, C. S., Goyal, M. K., & Kumar, S. (2007). Applying Fuzzy logic and the point count system to select landfill sites. Environmental monitoring and assessment, 135(1), 99-106. doi:10.1007/s10661-007-9713-3

OSL, I. (1990). Optimization Subroutine Library. Guide and Reference, SC23-0519.

Ostadrahimi, L., Mariño, M. A., & Afshar, A. (2012). Multi-reservoir operation rules: multi-swarm PSO-based optimization approach. Water Resources Management, 26(2), 407-427. doi:https://doi.org/10.1007/s11269-011-9924-9

Ostermann, S., Plankensteiner, K., Prodan, R., & Fahringer, T. (2010). GroudSim: an event-based simulation framework for computational grids and clouds. Paper presented at the European Conference on Parallel Processing.

Othman, S., & Yusop, M. K. (2002). Rice growth and nitrogen uptake as influenced by water management. Malaysian Journal of Soil Science, 6(spec.), 1-11.

Ouyang, F., Lü, H., Zhu, Y., Zhang, J., Yu, Z., Chen, X., & Li, M. (2014). Uncertainty analysis of downscaling methods in assessing the influence of climate change on hydrology. Stochastic Environmental Research and Risk Assessment, 28(4), 991-1010. doi:10.1007/s00477-013-0796-9

Papoulis, A., & Pillai, S. U. (2002). Probability, random variables, and stochastic processes: Tata McGraw-Hill Education.

Paschalis, A., Molnar, P., Fatichi, S., & Burlando, P. (2013). A stochastic model for high- resolution space- time precipitation simulation. Water Resources Research, 49(12), 8400-8417. doi:10.1002/2013WR014437

Patel, D. P., & Srivastava, P. K. (2013). Flood hazards mitigation analysis using remote sensing and GIS: correspondence with town planning scheme. Water Resources Management, 27(7), 2353-2368.

Paterson, R. R. M., Kumar, L., Taylor, S., & Lima, N. (2015). Future climate effects on suitability for growth of oil palms in Malaysia and Indonesia. Scientific reports, 5.

Pechlivanidis, I., Jackson, B., McIntyre, N., & Wheater, H. (2011). Catchment scale hydrological modelling: a review of model types, calibration approaches and uncertainty analysis methods in the context of recent developments in technology and applications. Global NEST Journal, 13(3), 193-214.

Peleg, N., & Morin, E. (2014). Stochastic convective rain- field simulation using a high- resolution synoptically conditioned weather generator (HiReS- WG). Water Resources Research, 50(3), 2124-2139. doi:10.1002/2013WR014836

Perak. (2011). Review of the national water resources study (2000-2050) and formulation of national water resources policy,Final Report 12, 13-Perak. (August-2011).

Perelet, R. (2007). Central Asia: background paper on climate change. Fighting climate change: Human solidarity in a divided world, UNDP Human Development Report, 2008.

Petter, P. (1992). GIS and remote sensing for soil erosion studies in semi-arid environments. Estimation of soil erosion parameters at different scales.

Pinto, R. J., Borges, C. T., & Maceira, M. E. (2013). An efficient parallel algorithm for large scale hydrothermal system operation planning. IEEE Transactions on Power Systems, 28(4), 4888-4896. doi:10.1109/TPWRS.2012.2236654

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

Ponnambalam, K., Vannelli, A., & Unny, T. (1989). An application of Karmarkar's interior-point linear programming algorithm for multi-reservoir operations optimization. Stochastic Hydrology and Hydraulics, 3(1), 17-29.

Porter, J. R., Liyong, X., Challinor, A., Cochrane, K., Howden, M., Iqbal, M., . . . Travasso, M. (2014). Food security and food production systems. IPCC 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 7. Final Draft, 1-82.

Poulin, A., Brissette, F., Leconte, R., Arsenault, R., & Malo, J.-S. (2011). Uncertainty of hydrological modelling in climate change impact studies in a Canadian, snow-dominated river basin. Journal of hydrology, 409(3), 626-636. doi:http://dx.doi.org/10.1016/j.jhydrol.2011.08.057

Praskievicz, S., & Chang, H. (2009). A review of hydrological modelling of basin-scale climate change and urban development impacts. Progress in Physical Geography, 33(5), 650-671.

Preisendorfer, R. W., & Mobley, C. D. (1988). Principal component analysis in meteorology and oceanography (Vol. 425): Elsevier Amsterdam.

Prudhomme, C., Reynard, N., & Crooks, S. (2002). Downscaling of global climate models for flood frequency analysis: where are we now? Hydrological Processes, 16(6), 1137-1150. doi:10.1002/hyp.1054

Racsko, P., Szeidl, L., & Semenov, M. (1991). A serial approach to local stochastic weather models. Ecological modelling, 57(1-2), 27-41.

Rahman, N. F. A., Ali, M. F., Ariffin, J., Khalid, K., & Mispan, M. R. (2014). A framework for integrated stream flow and sediment yield using SWAT in Langat watershed. J. Appl. Sci. Agric, 9(18), 156-162.

Raje, D., & Mujumdar, P. P. (2010). Reservoir performance under uncertainty in hydrologic impacts of climate change. Advances in Water Resources, 33(3), 312-326. doi:http://dx.doi.org/10.1016/j.advwatres.2009.12.008

Randall, D., Cleland, L., Kuehne, C. S., Link, G. W. B., & Sheer, D. P. (1997). Water supply planning simulation model using mixed-integer linear programming "engine". Journal of water resources planning and management, 123(2), 116-124. doi:org/10.1061/(ASCE)0733-9496(1997)123:2(116)

Rani, D., & Moreira, M. M. (2010). Simulation–optimization modeling: a survey and potential application in reservoir systems operation. Water Resources Management, 24(6), 1107-1138. doi:org/10.1007/s11269-009-9488-0

Ray, D. K., Mueller, N. D., West, P. C., & Foley, J. A. (2013). Yield trends are insufficient to double global crop production by 2050. PloS one, 8(6), e66428. doi:org/10.1371/journal.pone.0066428

Read, E., & Boshier, J. (1989). Biases in stochastic reservoir scheduling models. Dynamic programming for optimal water resources system management, 386-398.

Refsgaard, J., & Storm, B. (1995). Mike she. Chapter 23 in computer models of watershed hydrology, 809-846. VP Singh ed. Water Resources Pub., Highlands Ranch, CO.

Régnière, J., & St-Amant, R. (2007). Stochastic simulation of daily air temperature and precipitation from monthly normals in North America north of Mexico. International Journal of Biometeorology, 51(5), 415-430.

Rehana, S., & Mujumdar, P. (2014). Basin scale water resources systems modeling under cascading uncertainties. Water Resources Management, 28(10), 3127-3142.

Rezai, G., Shamsudin, M. N., & Mohamed, Z. (2016). Urban Agriculture: A Way Forward to Food and Nutrition Security in Malaysia. Procedia-Social and Behavioral Sciences, 216, 39-45.

Richardson, C. W. (1981). Stochastic simulation of daily precipitation, temperature, and solar radiation. Water Resources Research, 17(1), 182-190.

Richardson, C. W., & Wright, D. A. (1984). WGEN: A model for generating daily weather variables: US Department of Agriculture, Agricultural Research Service Washington, DC, USA.

Rockel, B., Will, A., & Hense, A. (2008). The regional climate model COSMO-CLM (CCLM). Meteorologische Zeitschrift, 17(4), 347-348.

Rogelj, J., Meinshausen, M., & Knutti, R. (2012). Global warming under old and new scenarios using IPCC climate sensitivity range estimates. Nature Climate Change, 2(4), 248.

Rosenblatt, F. (1962). Principles of neurodynamics.

Rosenthal, R. E. (1981). A nonlinear network flow algorithm for maximization of benefits in a hydroelectric power system. Operations research, 29(4), 763-786. doi:org/10.1287/opre.29.4.763

Rotmans, J. (1998). Methods for IA: The challenges and opportunities ahead. Environmental modeling and assessment, 3(3), 155-179.

Rowshon, M. K., Kwok, C. Y., & Lee, T. S. (2003). GIS-based scheduling and monitoring of irrigation delivery for rice irrigation system. Agricultural water management, 62(2), 105-116. doi:http://dx.doi.org/10.1016/S0378-3774(03)00092-1

Rummukainen, M. (1997). Methods for statistical downscaling of GCM simulations. SMHI Rapporter. Meteorologi och Klimatologi (Sweden). no. 80.

Rupp, D. E., Keim, R. F., Ossiander, M., Brugnach, M., & Selker, J. S. (2009). Time scale and intensity dependency in multiplicative cascades for temporal rainfall disaggregation. Water Resources Research, 45(7). doi:10.1029/2008WR007321

Saadat, M., & Asghari, K. (2017). Reliability Improved Stochastic Dynamic Programming for Reservoir Operation Optimization. Water Resources Management, 31(6), 1795-1807.

Saadouli, N. (2010). Computationally efficient solution algorithm for a large scale stochastic dynamic program. Procedia Computer Science, 1(1), 1397-1405. doi:https://doi.org/10.1016/j.procs.2010.04.155

Salami, A. W., Mohammed, A. A., & Okeola, O. G. (2014). Evaluation of Climate Change Impact on Runoff in the Kainji Lake Basin Using Artificial Neural Network Model (ANN). Malaysian Journal of Civil Engineering, 26(26), 35-50.

Salas, J. D. (1993). Analysis and modelling of hydrological time series. Handbook of hydrology, 19.

Saleh, A., & Du, B. (2004). Evaluation of SWAT and HSPF within BASINS program for the upper North Bosque River watershed in central Texas. Transactions of the ASAE, 47(4), 1039. doi:10.13031/2013.16577

Sandoval-Solis, S., McKinney, D., & Loucks, D. (2010). Sustainability index for water resources planning and management. Journal of water resources planning and management, 137(5), 381-390.

Sani, S. F. M., Ismail, W. R., & Mohd, S. A. (2012). Evaluation of Sediment Budget of Bukit Merah Reservoir and its Catchment Area, Perak, Malaysia. Malaysian Journal of Environmental Management 13(1): 69-79.

Sarkar, J., Chicholikar, J., & Rathore, L. (2015). Predicting future changes in temperature and precipitation in arid climate of Kutch, Gujarat: analyses based on LARS-WG model. CURRENT SCIENCE, 109(11), 2084.

Sato, T., Qadir, M., Yamamoto, S., Endo, T., & Zahoor, A. (2013). Global, regional, and country level need for data on wastewater generation, treatment, and use. Agricultural water management, 130(Supplement C), 1-13. doi:https://doi.org/10.1016/j.agwat.2013.08.007

Schneider, S. H., Easterling, W. E., & Mearns, L. O. (2000). Adaptation: Sensitivity to natural variability, agent assumptions and dynamic climate changes. Climatic change, 45(1), 203-221. doi:org/10.1023/A:1005

Schuol, J., Abbaspour, K. C., Srinivasan, R., & Yang, H. (2008). Estimation of freshwater availability in the West African sub-continent using the SWAT hydrologic model. Journal of hydrology, 352(1), 30-49. doi:http://dx.doi.org/10.1016/j.jhydrol.2007.12.025

SCS. (1956). Hydrology. National Engineering Handbook, Supplement A, Section 4. Soil Conservation Service (Vol. US Department of Agriculture:Washington, DC; Chapter 10.).

SCS. (1972). Hydrology, National Engineering Handbook, Supplement A, Section 4, Chapter 10, Soil Conservation Service, U.S.D.A., Washington, D.C.

Sechi, G. M., & Sulis, A. (2009). Water system management through a mixed optimization-simulation approach. Journal of water resources planning and management, 135(3), 160-170. doi:https://doi.org/10.1061/(ASCE)0733-9496(2009)135:3(160)

See, L., & Openshaw, S. (2000). A hybrid multi-model approach to river level forecasting. Hydrological sciences journal, 45(4), 523-536. doi:org/10.1080/02626660009492354

Seifi, A., & Hipel, K. W. (2001). Interior-point method for reservoir operation with stochastic inflows. Journal of water resources planning and management, 127(1), 48-57. doi:http://dx.doi.org/10.1061/(ASCE)0733-9496(2001)127:1(48)#sthash.zhDgMxtF.dpuf

Seifollahi-Aghmiuni, S., Haddad, O. B., & Mariño, M. (2013). Water distribution network risk analysis under simultaneous consumption and roughness uncertainties. Water Resources Management, 27(7), 2595-2610.

Seifollahi-Aghmiuni, S., Haddad, O. B., Omid, M. H., & Mariño, M. A. (2011). Long-term efficiency of water networks with demand uncertainty. Paper presented at the Proceedings of the Institution of Civil Engineers-Water Management.

Semenov, & Barrow. (1997). Use of a stochastic weather generator in the development of climate change scenarios. Climatic change, 35(4), 397-414. doi:10.1023/A:1005342632279

Semenov, M. A., Barrow, E. M., & Lars-Wg, A. (2002). A stochastic weather generator for use in climate impact studies. User Man Herts UK.

Semenov, M. A., Brooks, R. J., Barrow, E. M., & Richardson, C. W. (1998). Comparison of the WGEN and LARS-WG stochastic weather generators for diverse climates. Climate Research, 10(2), 95-107.

Semenov, M. A., & Porter, J. R. (1995). Climatic variability and the modelling of crop yields. Agricultural and Forest Meteorology, 73(3), 265-283. doi:http://dx.doi.org/10.1016/0168-1923(94)05078-K

Setegn, S. G., Srinivasan, R., & Dargahi, B. (2008). Hydrological modelling in the Lake Tana Basin, Ethiopia using SWAT model. The Open Hydrology Journal, 2(1).

Shaaban, A. J., Amin, M., Chen, Z., & Ohara, N. (2010). Regional modeling of climate change impact on Peninsular Malaysia water resources. Journal of Hydrologic Engineering, 16(12), 1040-1049.

Shao, Q., Zhang, L., & Wang, Q. (2016). A hybrid stochastic-weather-generation method for temporal disaggregation of precipitation with consideration of seasonality and within-month variations. Stochastic Environmental Research and Risk Assessment, 30(6), 1705-1724.

Sharifi, E., Unami, K., Yangyuoru, M., & Fujihara, M. (2016). Verifying optimality of rainfed agriculture using a stochastic model for drought occurrence. Stochastic Environmental Research and Risk Assessment, 30(5), 1503-1514.

Sharip, Z., & Zakaria, S. (2007). Lakes and reservoir in Malaysia: Management and research challenges. Paper presented at the Proceedings of Taal2007: the 12th World lake conference.

Sharip, Z., & Zaki, A. T. A. (2014). The effects of season and sand mining activities on thermal regime and water quality in a large shallow tropical lake. Environmental monitoring and assessment, 186(8), 4959-4969.

Sharma, A., & Lall, U. (1999). A nonparametric approach for daily rainfall simulation. Mathematics and Computers in Simulation, 48(4), 361-371. doi:http://dx.doi.org/10.1016/S0378-4754(99)00016-6

Sharma, P. J., Patel, P., & Jothiprakash, V. (2016). Efficient discretization of state variables in stochastic dynamic programming model of Ukai reservoir, India. ISH Journal of Hydraulic Engineering, 22(3), 293-304.

Shaw, A. (2016). Determination of Optimal Operating Schemes for a Multi-Reservoir System Under Environmental Constraints.

Shaw, E. M., Beven, K. J., Chappell, N. A., & Lamb, R. (2010). Hydrology in practice: CRC Press.

Shourian, M., Mousavi, S., & Tahershamsi, A. (2008). Basin-wide water resources planning by integrating PSO algorithm and MODSIM. Water Resources Management, 22(10), 1347-1366. doi:https://doi.org/10.1007/s11269-007-9229-1

Shuhaimi-Othman, M., Ahmad, A., & Norziana, G. (2010). Metal concentrations in Bukit Merah Lake, perak. Sains Malaysiana, 39(6), 883-889.

Siaw-Yang, Y. (1988). Food resource utilization partitioning of fifteen fish species at Bukit Merah Reservoir, Malaysia. Hydrobiologia, 157(2), 143-160.

Simon, T., Wang, D., Hense, A., Simmer, C., & Ohlwein, C. (2013). Generation and transfer of internal variability in a regional climate model. Tellus A: Dynamic Meteorology and Oceanography, 65(1), 22485. doi:https://doi.org/10.3402/tellusa.v65i0.22485

Simonovic, S. P., & Arunkumar, R. (2016). Comparison of static and dynamic resilience for a multipurpose reservoir operation. Water Resources Research. doi:10.1002/2016WR019551

Singh, A. (2014). Simulation and optimization modeling for the management of groundwater resources. II: Combined applications. Journal of Irrigation and Drainage Engineering, 140(4), 04014002. doi:org/10.1061/(ASCE)IR.1943-4774.0000689

Singh, A., Panda, S. N., Saxena, C., Verma, C., Uzokwe, V. N., Krause, P., & Gupta, S. (2015). Optimization modeling for conjunctive use planning of surface water and groundwater for irrigation. Journal of Irrigation and Drainage Engineering, 142(3), 04015060. doi:org/10.1061/(ASCE)IR.1943-4774.0000977

Singh, S., Amartalingam, R., Wan Harun, W., & Islam, M. (1996). Simulated impact of climate change on rice production in Peninsular Malaysia. Paper presented at the Proceeding of National Conference on Climate Change.

Sirdari, Z. Z., Ghani, A. A., & Hasan, Z. A. (2013). Application of 3D Numerical Model in Bedload Transport and Bed Morphology of River Channel Confluence. Paper presented at the Proceedings of 35th IAHR World Congress: the Wise Find Pleasure in Water. China.

Siwar, C., Diana, N., Yasar, M., & Morshed, G. (2014). Issues and challenges facing rice production and food security in the granary areas in the East Coast Economic Region (ECER), Malaysia. Res J Appl Sci Eng Tech, 7(4), 711-722.

Skamarock WC, K. J., Dudhia J, G. D., Barker DM, , & Wang W, P. J. (2008). A Description of the Advanced Research WRF Version 3. Retrieved from

Smail, W. R., & Najib, S. A. M. (2011). Sediment and nutrient balance of Bukit Merah Reservoir, Perak (Malaysia). Lakes & Reservoirs: Research & Management, 16(3), 179-184. doi:10.1111/j.1440-1770.2011.00453.x

Soleimani, S., Bozorg-Haddad, O., & Loáiciga, H. A. (2016). Reservoir operation rules with uncertainties in reservoir inflow and agricultural demand derived with stochastic dynamic programming. Journal of Irrigation and Drainage Engineering, 142(11), 04016046.

Solomatine, D., & Torres, L. (1996). Neural network approximation of a hydrodynamic model in optimizing reservoir operation. Paper presented at the Proc. 2nd Intern. Conference on Hydroinformatics, Zurich.

Soundharajan, B.-S., Adeloye, A. J., & Remesan, R. (2016). Evaluating the variability in surface water reservoir planning characteristics during climate change impacts assessment. Journal of hydrology, 538, 625-639. doi:https://doi.org/10.1016/j.jhydrol.2016.04.051

Spruill, C., Workman, S., & Taraba, J. (2000). Simulation of daily and monthly stream discharge from small watersheds using the SWAT model. Transactions of the ASAE, 43(6), 1431.

Sreenivasan, K., & Vedula, S. (1996). Reservoir operation for hydropower optimization: a chance-constrained approach. Sadhana, 21(4), 503-510. doi:10.1007/BF02745572

Srikanthan, R., & McMahon, T. (2001). Stochastic generation of annual, monthly and daily climate data: A review. Hydrology and Earth System Sciences Discussions, 5(4), 653-670.

Stedinger, J. R., Sule, B. F., & Loucks, D. P. (1984). Stochastic dynamic programming models for reservoir operation optimization. Water Resources Research, 20(11), 1499-1505.

Stéfanon, M., Drobinski, P., D'Andrea, F., Lebeaupin-Brossier, C., & Bastin, S. (2014). Soil moisture-temperature feedbacks at meso-scale during summer heat waves over Western Europe. Climate Dynamics, 42(5-6), 1309-1324. doi: 10.1007/s00382-013-1794-9

Stocker, T. (2014). Climate change 2013: the physical science basis: Working Group I contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change: Cambridge University Press.

Stöckle, C. O., Donatelli, M., & Nelson, R. (2003). CropSyst, a cropping systems simulation model. European journal of agronomy, 18(3), 289-307. doi:http://dx.doi.org/10.1016/S1161-0301(02)00109-0

Storch, V., Zorita, E., & Cubasch, U. (1993). Downscaling of global climate change estimates to regional scales: an application to Iberian rainfall in wintertime. Journal of Climate, 6(6), 1161-1171. doi:org/10.1175/1520-0442(1993)006<1161:DOGCCE>2.0.CO;2

Storch, V. H., Langenberg, H., & Feser, F. (2000). A spectral nudging technique for dynamical downscaling purposes. Monthly Weather Review, 128(10), 3664-3673. doi:http://dx.doi.org/10.1175/1520-0493(2000)128<3664:ASNTFD>2.0.CO;2

Suen, J. P., & Eheart, J. W. (2006). Reservoir management to balance ecosystem and human needs: Incorporating the paradigm of the ecological flow regime. Water Resources Research, 42(3). doi:10.1029/2005WR004314

Suhaila, J., Deni, S. M., Zin, W. Z. W., & Jemain, A. A. (2010). Trends in peninsular Malaysia rainfall data during the southwest monsoon and northeast monsoon seasons: 1975–2004. Sains Malaysiana, 39(4), 533-542.

Suhaila, J., & Jemain, A. A. (2009a). A comparison of the rainfall patterns between stations on the East and the West coasts of Peninsular Malaysia using the smoothing model of rainfall amounts. Meteorological Applications, 16(3), 391-401.

Suhaila, J., & Jemain, A. A. (2009b). Investigating the impacts of adjoining wet days on the distribution of daily rainfall amounts in Peninsular Malaysia. Journal of hydrology, 368(1), 17-25.

Sulaiman, W., & Hamid, M. R. (1997). Suspended sediment and turbidity relationships for individual and multiple catchments. Pertanika Journal of Science and Technology, 5, 127-137.

Sunyer, M., Madsen, H., & Ang, P. (2012). A comparison of different regional climate models and statistical downscaling methods for extreme rainfall estimation under climate change. Atmospheric Research, 103, 119-128.

Suykens, J. A. (2001). Nonlinear modelling and support vector machines. Paper presented at the Instrumentation and Measurement Technology Conference, 2001. IMTC 2001. Proceedings of the 18th IEEE.

Syafrina, A., Zalina, M., & Juneng, L. (2015). Historical trend of hourly extreme rainfall in Peninsular Malaysia. Theoretical and Applied Climatology, 120(1-2), 259-285.

Taha, H. A. (1992). Operations research: an introduction: Macmillan.

Talebizadeh, M., Morid, S., Ayyoubzadeh, S. A., & Ghasemzadeh, M. (2010). Uncertainty analysis in sediment load modeling using ANN and SWAT model. Water Resources Management, 24(9), 1747-1761.

Talib, S., Yusoff, M., Hasan, Z., Ismail, W., & Abustan, M. (2016). Nutrient Concentration Distribution in Sediment and Overlying Water at Bukit Merah Reservoir, Perak. Paper presented at the MATEC Web of Conferences.

Tan, M. L., Ibrahim, A. L., Yusop, Z., Duan, Z., & Ling, L. (2015). Impacts of land-use and climate variability on hydrological components in the Johor River basin, Malaysia. Hydrological sciences journal, 60(5), 873-889.

Tangang, F. T., Juneng, L., & Ahmad, S. (2007). Trend and interannual variability of temperature in Malaysia: 1961–2002. Theoretical and Applied Climatology, 89(3-4), 127-141.

Tao, J., & Barros, A. P. (2017). Multi-year atmospheric forcing datasets for hydrologic modeling in regions of complex terrain – Methodology and evaluation over the Integrated Precipitation and Hydrology Experiment 2014 domain. Journal of hydrology. doi:https://doi.org/10.1016/j.jhydrol.2016.12.058

Tayebiyan, A., Mohammad, T. A., Ghazali, A. H., Malek, M., & Mashohor, S. (2016). Potential Impacts of Climate Change on Precipitation and Temperature at Jor Dam Lake. Pertanika Journal of Science & Technology, 24(1).

Tayfur, G. (2017). Modern optimization methods in water resources planning, engineering and management. Water Resources Management, 1-29.

Te Chow, V. (1988). Applied hydrology: Tata McGraw-Hill Education.

Teegavarapu, R. S., & Simonovic, S. P. (2000). Short-term operation model for coupled hydropower reservoirs. Journal of water resources planning and management, 126(2), 98-106. doi:http://dx.doi.org/10.1061/(ASCE)0733-9496(2000)126:2(98)

Tejada- Guibert, J. A., Johnson, S. A., & Stedinger, J. R. (1993). Comparison of two approaches for implementing multireservoir operating policies derived using stochastic dynamic programming. Water Resources Research, 29(12), 3969-3980. doi:10.1029/93WR02277

Thompson, J., Green, A., Kingston, D., & Gosling, S. (2013). Assessment of uncertainty in river flow projections for the Mekong River using multiple GCMs and hydrological models. Journal of hydrology, 486, 1-30.

Tidwell, V. C., Passell, H. D., Conrad, S. H., & Thomas, R. P. (2004). System dynamics modeling for community-based water planning: Application to the Middle Rio Grande. Aquatic Sciences-Research Across Boundaries, 66(4), 357-372.

Tipping, M. E. (2001). Sparse Bayesian learning and the relevance vector machine. Journal of machine learning research, 1(Jun), 211-244.

Tolika, K., & Maheras, P. (2005). Spatial and temporal characteristics of wet spells in Greece. Theoretical and Applied Climatology, 81(1), 71-85.

Tolson, B. A., & Shoemaker, C. A. (2007). Cannonsville reservoir watershed SWAT2000 model development, calibration and validation. Journal of hydrology, 337(1), 68-86.

Tospornsampan, J., Kita, I., Ishii, M., & Kitamura, Y. (2005). Optimization of a multiple reservoir system operation using a combination of genetic algorithm and discrete differential dynamic programming: a case study in Mae Klong system, Thailand. Paddy and Water Environment, 3(1), 29-38. doi:10.1007/s10333-005-0070-y

Trenberth, K. E. (2011). Changes in precipitation with climate change. Climate Research, 47(1-2), 123-138.

Tripathi, A., Tripathi, D. K., Chauhan, D., Kumar, N., & Singh, G. (2016). Paradigms of climate change impacts on some major food sources of the world: A review on current knowledge and future prospects. Agriculture, Ecosystems & Environment, 216, 356-373.

Tripathi, S., & Srinivas, V. (2005). Downscaling of general circulation models to assess the impact of climate change on rainfall of India. Paper presented at the Proceedings of International Conference on Hydrological Perspectives for Sustainable Development (HYPESD-2005).

Trott, W. J., & Yeh, W. W. (1973). Optimization of multiple reservoir system. Journal of the Hydraulics Division, 99(10), 1865-1884.

Trzaska, S., & Schnarr, E. (2014). A review of downscaling methods for climate change projections. United States Agency for International Development by Tetra Tech ARD, 1-42.

Tsai, F. T.-C., Katiyar, V., Toy, D., & Goff, R. A. (2009). Conjunctive management of large-scale pressurized water distribution and groundwater systems in semi-arid area with parallel genetic algorithm. Water Resources Management, 23(8), 1497. doi:10.1007/s11269-008-9338-5

Tu, M.-Y., Hsu, N.-S., & Yeh, W. W.-G. (2003). Optimization of reservoir management and operation with hedging rules. Journal of water resources planning and management, 129(2), 86-97. doi:org/10.1061/(ASCE)0733-9496(2003)129:2(86)

Tukimat, N., Harun, S., & Shahid, S. (2017). Modeling Irrigation Water Demand in a Tropical Paddy Cultivated Area in the Context of Climate Change. Journal of water resources planning and management, 143(7), 05017003.

Tukimat, N. N. A., & Harun, S. (2014). Optimization of Water Supply Reservoir in the Framework of Climate Variation. International Journal of Software Engineering and Its Applications, 8(3), 361-378.

Turgeon, A. (1981). A decomposition method for the long- term scheduling of reservoirs in series. Water Resources Research, 17(6), 1565-1570.

Turner, S. W., Ng, J. Y., & Galelli, S. (2017). Examining global electricity supply vulnerability to climate change using a high-fidelity hydropower dam model. Science of the Total Environment, 590, 663-675.

Turral, H., Burke, J., & Faurès, J.-M. (2011). Climate change, water and food security: FAO.

Umamahesh, N., & Sreenivasulu, P. (1997). Technical communication: two-phase stochastic dynamic programming model for optimal operation of irrigation reservoir. Water Resources Management, 11(5), 395-406.

Unami, K., Abagale, F. K., Yangyuoru, M., Alam, A. H. M. B., & Kranjac-Berisavljevic, G. (2010). A stochastic differential equation model for assessing drought and flood risks. Stochastic environmental research and risk assessment, Publisher Name Springer-Verlag, 24(5), 725-733. doi:https://doi.org/10.1007/s00477-009-0359-2

Unami, K., Yangyuoru, M., Alam, A. H. M. B., & Kranjac-Berisavljevic, G. (2013). Stochastic control of a micro-dam irrigation scheme for dry season farming. Stochastic Environmental Research and Risk Assessment, 27(1), 77-89.

Unde, M. G., & Dhakal, S. (2009). Sediment characteristics at river confluences: a case study of the Mula-Kas confluence, Maharashtra, India. Progress in Physical Geography, 33(2), 208-223.

USCB. (2010). United States Census Bureau, State population data. Retrieved from <http://quickfacts.census.gov/qfd/index.html. > on October, 2010.

Van Aalst, M. K. (2006). The impacts of climate change on the risk of natural disasters. Disasters, 30(1), 5-18.

Van Griensven, A., Meixner, T., Srinivasan, R., & Grunwald, S. (2008). Fit-for-purpose analysis of uncertainty using split-sampling evaluations. Hydrological sciences journal, 53(5), 1090-1103.

Van Mullem, J. (1991). Runoff and peak discharges using Green-Ampt infiltration model. Journal of Hydraulic Engineering, 117(3), 354-370.

Van Nguyen, N., & Ferrero, A. (2006). Meeting the challenges of global rice production: Springer.

Van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., . . . Lamarque, J.-F. (2011). The representative concentration pathways: an overview. Climatic change, 109(1-2), 5.

Van Vuuren, D. P., Kriegler, E., O'neill, B. C., Ebi, K. L., Riahi, K., Carter, T. R., . . . Mathur, R. (2014). A new scenario framework for climate change research: scenario matrix architecture. Climatic change, 122(3), 373.

Vandecasteele, I., Bianchi, A., e Silva, F. B., Lavalle, C., & Batelaan, O. (2014). Mapping current and future European public water withdrawals and consumption. Hydrology and Earth System Sciences, 18(2), 407.

Vanderbei, R. (2006). LOQO user’s manual version 4.05. In P. University (Ed.).

Vapnik, V. N., & Vapnik, V. (1998). Statistical learning theory (Vol. 1): Wiley New York.

Vedula, S., & Kumar, D. N. (1996). An integrated model for optimal reservoir operation for irrigation of multiple crops. Water Resources Research, 32(4), 1101-1108.

Vedula, S., & Mujumdar, P. (1992). Optimal reservoir operation for irrigation of multiple crops. Water Resources Research, 28(1), 1-9.

Verdin, A., Rajagopalan, B., Kleiber, W., & Katz, R. W. (2015). Coupled stochastic weather generation using spatial and generalized linear models. Stochastic Environmental Research and Risk Assessment, 29(2), 347-356.

Vicuna, S., Dracup, J. A., Lund, J. R., Dale, L. L., & Maurer, E. P. (2010). Basin Scale Water System Operations with Uncertain Future Climate Conditions. Global Environmental Change, 17, 59-72.

Vonk, E., Xu, Y., Booij, M. J., Zhang, X., & Augustijn, D. C. (2014). Adapting multireservoir operation to shifting patterns of water supply and demand. Water Resources Management, 28(3), 625-643. doi:org/10.1007/s11269-013-0499-5

Vrac, M., Stein, M., & Hayhoe, K. (2007). Statistical downscaling of precipitation through nonhomogeneous stochastic weather typing. Climate Research, 34(3), 169-184.

Wahid, A. N. A., Rahim, S. A., Rahim, K. A., & Harun, A. R. (2016). Nitrogen Use Efficiency in Mr219-4 And Mr219-9 Rice Mutant Lines Under Different Water Potentials and Nitrogen Levels Using 15 N Isotopic Tracer Technique. Malaysian Journal of Analytical Sciences, 20(3), 500-509. doi:org/10.17576/mjas-2016-2003-06

Wang, K., & 王可昳. (2016). Variability of and climate change impacts on the terrestrial hydrologic processes. HKU Theses Online (HKUTO).

Watanabe, T., & Kume, T. (2009). A general adaptation strategy for climate change impacts on paddy cultivation: special reference to the Japanese context. Paddy and Water Environment, 7(4), 313. doi:https://doi.org/10.1007/s10333-009-0179-5

Watts, R. J., Richter, B. D., Opperman, J. J., & Bowmer, K. H. (2011). Dam reoperation in an era of climate change. Marine and Freshwater Research, 62(3), 321-327. doi:org/10.1071/MF10047

Wayne, G. (2013). The beginner‘s guide to representative concentration pathways. . Skeptical Science.

Wheater, H., Chandler, R., Onof, C., Isham, V., Bellone, E., Yang, C., . . . Segond, M.-L. (2005). Spatial-temporal rainfall modelling for flood risk estimation. Stochastic Environmental Research and Risk Assessment, 19(6), 403-416.

Wi, S., Yang, Y., Steinschneider, S., Khalil, A., & Brown, C. (2015). Calibration approaches for distributed hydrologic models in poorly gaged basins: implication for streamflow projections under climate change. Hydrology and Earth System Sciences, 19(2), 857-876.

Wilby, R., Charles, S., Zorita, E., Timbal, B., Whetton, P., & Mearns, L. (2004). Guidelines for use of climate scenarios developed from statistical downscaling methods. Supporting material of the Intergovernmental Panel on Climate Change, available from the DDC of IPCC TGCIA, 27.

Wilby, R., & Dawson, C. (2007). SDSM 4.2-A decision support tool for the assessment of regional climate change impacts. User Manual. London, UK.

Wilby, R. L., Dawson, C. W., & Barrow, E. M. (2002). SDSM—a decision support tool for the assessment of regional climate change impacts. Environmental Modelling & Software, 17(2), 145-157.

Wilby, R. L., & Harris, I. (2006). A framework for assessing uncertainties in climate change impacts: Low- flow scenarios for the River Thames, UK. Water Resources Research, 42(2). doi:10.1029/2005WR004065

Wilby, R. L., & Wigley, T. (1997). Downscaling general circulation model output: a review of methods and limitations. Progress in Physical Geography, 21(4), 530-548.

Wilby, R. L., Wigley, T., Conway, D., Jones, P., Hewitson, B., Main, J., & Wilks, D. (1998). Statistical downscaling of general circulation model output: a comparison of methods. Water Resources Research, 34(11), 2995-3008. doi:10.1029/98WR02577

Wilks, D. S. (1992). Adapting stochastic weather generation algorithms for climate change studies. Climatic change, 22(1), 67-84. doi:10.1007/BF00143344

Wilks, D. S. (1999). Multisite downscaling of daily precipitation with a stochastic weather generator. Climate Research, 11(2), 125-136.

Wilks, D. S. (2010). Use of stochastic weathergenerators for precipitation downscaling. Wiley Interdisciplinary Reviews: Climate Change, 1(6), 898-907.

Wilks, D. S. (2011). Statistical methods in the atmospheric sciences (Vol. 100): Academic press.

Wilks, D. S. (2012). Stochastic weather generators for climate- change downscaling, part II: multivariable and spatially coherent multisite downscaling. Wiley Interdisciplinary Reviews: Climate Change, 3(3), 267-278.

Wilks, D. S., & Wilby, R. L. (1999). The weather generation game: a review of stochastic weather models. Progress in Physical Geography, 23(3), 329-357.

Winchell, M., Srinivasan, R., Di Luzio, M., & Arnold, J. (2007). ArcSWAT interface for SWAT2005 User's guide. Texas Agricultural Experiment Station and United States Department of Agriculture, Temple, TX.

Wong, C., Venneker, R., Jamil, A., & Uhlenbrook, S. (2011). Development of a gridded daily hydrometeorological data set for Peninsular Malaysia. Hydrological Processes, 25(7), 1009-1020.

Wood, A. W., Leung, L. R., Sridhar, V., & Lettenmaier, D. (2004). Hydrologic implications of dynamical and statistical approaches to downscaling climate model outputs. Climatic change, 62(1), 189-216. doi:10.1023/B:CLIM.0000013685.99609.9e

Woolhiser. (1989). KINEROS, a kinematic runoff and erosion model. Documentation and Use Manual.

Woolhiser, D. (1992). Modeling daily precipitation–progress and problems. Statistics in the environmental and Earth sciences, 5, 71-89.

Wurbs, R. A. (1993). Reservoir-system simulation and optimization models. Journal of water resources planning and management, 119(4), 455-472.

Wurbs, R. A. (1998). Dissemination of generalized water resources models in the United States. Water International, 23(3), 190-198. doi:org/10.1080/02508069808686767

Xu, C.-y. (1999a). Climate change and hydrologic models: A review of existing gaps and recent research developments. Water Resources Management, 13(5), 369-382. doi:org/10.1023/A:1008190900459

Xu, C.-y. (1999b). From GCMs to river flow: a review of downscaling methods and hydrologic modelling approaches. Progress in Physical Geography, 23(2), 229-249.

Xu, C.-Y., & Singh, V. P. (2004). Review on regional water resources assessment models under stationary and changing climate. Water Resources Management, 18(6), 591-612. doi:10.1007/s11269-004-9130-0

Xue, Y., Janjic, Z., Dudhia, J., Vasic, R., & De Sales, F. (2014). A review on regional dynamical downscaling in intraseasonal to seasonal simulation/prediction and major factors that affect downscaling ability. Atmospheric Research, 147-148(Supplement C), 68-85. doi:https://doi.org/10.1016/j.atmosres.2014.05.001

Yadav, S. K., Singh, S. K., Gupta, M., & Srivastava, P. K. (2014). Morphometric analysis of Upper Tons basin from Northern Foreland of Peninsular India using CARTOSAT satellite and GIS. Geocarto International, 29(8), 895-914.

Yakowitz, S. (1982). Dynamic programming applications in water resources. Water Resources Research, 18(4), 673-696.

Yan, G., Wen-Jie, D., Fu-Min, R., Zong-Ci, Z., & Jian-Bin, H. (2013). Surface Air Temperature Simulations over China with CMIP5 and CMIP3. Advances in Climate Change Research, 4(3), 145-152. doi:http://dx.doi.org/10.3724/SP.J.1248.2013.145

Yang, J., Reichert, P., Abbaspour, K., Xia, J., & Yang, H. (2008). Comparing uncertainty analysis techniques for a SWAT application to the Chaohe Basin in China. Journal of hydrology, 358(1), 1-23.

Yang, T.-C., Kuo, C.-M., Liu, C.-C., Tseng, H.-W., & Yu, P.-S. (2013). Effects of Domain Selection on Singular-Value-Decomposition Based Statistical Downscaling of Monthly Rainfall Accumulation in Southern Taiwan. Terrestrial, Atmospheric & Oceanic Sciences, 24(3). doi:10.3319/TAO.2013.01.09.01(A)

Yangyuoru M, U. K., Kawachi T (2006). A prototype tank irrigation scheme with rainwater harvesting. In R. M. f. D. M. a. S. D. Proceedings of the 10th

SEARNET International Conference on Rainwater Harvesting and Management in Africa, 81-88. (Ed.).

Yeh, W. W. G. (1985). Reservoir management and operations models: A state- of- the- art review. Water Resources Research, 21(12), 1797-1818. doi:10.1029/WR021i012p01797

Yi, J., Yubazaki, N., & Hirota, K. (2003). Anti-swing and positioning control of overhead traveling crane. Information Sciences, 155(1), 19-42. doi:org/10.1016/S0020-0255(03)00127-0

Yohe, G. (2000). Assessing the role of adaptation in evaluating vulnerability to climate change. Climatic change, 46(3), 371-390. doi:org/10.1023/A:1005659629316

Young, Onstad, C., Bosch, D., & Anderson, W. (1987). AGNPS, Agricultural Non-Point-Source Pollution Model. A Watershed Analysis Tool. US Dept. of Agr. Conservation Research Report 35.

Young, G. K. (1967). Finding reservoir operating rules. Journal of the Hydraulics Division, 93(6), 297-322.

Yuan, X., Zhang, Y., & Yuan, Y. (2008). Improved self-adaptive chaotic genetic algorithm for hydrogeneration scheduling. Journal of water resources planning and management, 134(4), 319-325. doi:org/10.1061/(ASCE)0733-9496(2008)134:4(319)

Yue, W., Cai, Y., Xu, L., Tan, Q., & Yin, X. A. (2016). Adaptation strategies for mitigating agricultural GHG emissions under dual-level uncertainties with the consideration of global warming impacts. Stochastic Environmental Research and Risk Assessment, 1-19.

Yusof, F., Hui-Mean, F., Suhaila, J., Yusop, Z., & Ching-Yee, K. (2014). Rainfall characterisation by application of standardised precipitation index (SPI) in Peninsular Malaysia. Theoretical and Applied Climatology, 115(3-4), 503-516.

Yusof, M. F., Azamathulla, H. M., & Abdullah, R. (2014). Prediction of soil erodibility factor for Peninsular Malaysia soil series using ANN. Neural Computing and Applications, 24(2), 383-389.

Zadeh, L. A. (1965). Fuzzy sets. Information and Control, 8(3), 338-353. doi:http://dx.doi.org/10.1016/S0019-9958(65)90241-X

Zadeh, L. A. (1983). The role of fuzzy logic in the management of uncertainty in expert systems. Fuzzy Sets and Systems, 11(1), 199-227. doi:http://dx.doi.org/10.1016/S0165-0114(83)80081-5

Zakaria, N. A., Azamathulla, H. M., Chang, C. K., & Ghani, A. A. (2010). Gene expression programming for total bed material load estimation—a case study. Science of the Total Environment, 408(21), 5078-5085.

Zakaria, S., Shaaban, A. J., Chan, Y., & Rahman, S. A. (2007). Impact of climate change on Malaysia water resources.

Zargar, M., Samani, H. M., & Haghighi, A. (2016). Optimization of gated spillways operation for flood risk management in multi-reservoir systems. Natural Hazards, 82(1), 299-320. doi:https://doi.org/10.1007/s11069-016-2202-7

Zarzycki, C. M., Jablonowski, C., & Taylor, M. A. (2014). Using variable-resolution meshes to model tropical cyclones in the Community Atmosphere Model. Monthly Weather Review, 142(3), 1221-1239. doi:http://dx.doi.org/10.1175/MWR-D-13-00179.1

Zhang, H., & Huang, G. H. (2013). Development of climate change projections for small watersheds using multi-model ensemble simulation and stochastic weather generation. Climate Dynamics, 1-17. doi:10.1007/s00382-012-1490-1

Zhang, L., Guo, P., Fang, S., & Li, M. (2014). Monthly optimal reservoirs operation for multicrop deficit irrigation under fuzzy stochastic uncertainties. Journal of Applied Mathematics, 2014.

Zhang, W., Liu, P., Wang, H., Chen, J., Lei, X., & Feng, M. (2017). Reservoir adaptive operating rules based on both of historical streamflow and future projections. Journal of hydrology, 553, 691-707.

Zhang, X., & Garbrecht, J. D. (2003). Evaluation of CLIGEN precipitation parameters and their implication on WEPP runoff and erosion prediction. Transactions of the ASAE, 46(2), 311.

Zhang, Y., Jiang, Z., Ji, C., & Sun, P. (2015). Contrastive analysis of three parallel modes in multi-dimensional dynamic programming and its application in cascade reservoirs operation. Journal of hydrology, 529, 22-34. doi:https://doi.org/10.1016/j.jhydrol.2015.07.017

Zhang, Z., Zhang, S., Wang, Y., Jiang, Y., & Wang, H. (2013). Use of parallel deterministic dynamic programming and hierarchical adaptive genetic algorithm for reservoir operation optimization. Computers & Industrial Engineering, 65(2), 310-321.

Zhao, T., Zhao, J., & Yang, D. (2012). Improved dynamic programming for hydropower reservoir operation. Journal of water resources planning and management, 140(3), 365-374. doi:org/10.1061/(ASCE)WR.1943-5452.0000343

Zhou, J., Liu, Y., Guo, H., & He, D. (2014). Combining the SWAT model with sequential uncertainty fitting algorithm for streamflow prediction and uncertainty analysis for the Lake Dianchi Basin, China. Hydrological Processes, 28(3), 521-533.

Zin, W. Z. W., Jamaludin, S., Deni, S. M., & Jemain, A. A. (2010). Recent changes in extreme rainfall events in Peninsular Malaysia: 1971–2005. Theoretical and Applied Climatology, 99(3-4), 303.

Zin, W. Z. W., Jemain, A. A., & Ibrahim, K. (2013). Analysis of drought condition and risk in Peninsular Malaysia using Standardised Precipitation Index. Theoretical and Applied Climatology, 111(3-4), 559-568.

Zorita, E., & Von Storch, H. (1999). The analog method as a simple statistical downscaling technique: comparison with more complicated methods. Journal of Climate, 12(8), 2474-2489. doi:org/10.1175/1520-0442(1999)012<2474:TAMAAS>2.0.CO;2

Zou, R., Lung, W. S., & Wu, J. (2007). An adaptive neural network embedded genetic algorithm approach for inverse water quality modeling. Water Resources Research, 43(8). doi:10.1029/2006WR005158