Sejatan dan Perseimbangan Air di Malaysia, 1971-1980

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Prakata

Sebagai sebuah kursus perlu ke arah penganugerahan ijazah sarjana muda sastera, latihan ilmiah adalah sebuah kursus yang bercorak penyelidikan yang memerlukan kajian oleh para pelajar secara perseorangan dengan bimbingan seorang pensyarah. Walaupun penulisan penyelidikan ini merupakan kajian asli yang dibuat oleh seseorang penuntut dalam tajuk yang menarik minatnya, beberapa kuliah mengenai falsafah dan methodologi penulisan sesebuah latihan ilmiah telah diadakan. Perbincangan mengenai tajuk penyelidikan yang terpilih secara kumpulan juga diadakan bersama-sama dengan rakan-rakan sekursus dan para pensyarah di mana setiap penuntut diperlukan membentangkan teknik-teknik pengumpulan dan penganalisaan data-data penyelidikannya. Dengan hasil usaha ini, adalah diharapkan bahawa sesebuah penulisan latihan ilmiah yang tinggi mutunya dapat dihasilkan.

Tajuk latihan ilmiah ini adalah mengenai sejatan dan perseimbangan air di Malaysia di mana sipengkaji telah menganalisakan sejatan dan perseimbangan air di 15 buah stesyen kajicuaca yang utama untuk tempoh masa antara tahun 1971 sehingga 1980. Di samping menganalisakan perseimbangan air dan sejatan pada stesyen-stesyen kajicuaca yang utama ini, suatu usaha untuk membandingkan hasil-hasil penyelidikan ini dengan analisa kajian Nieuwolt bagi stesyen-stesyen kajicuaca di Semenanjung Malaysia di antara tahun 1957 sehingga 1962 juga diiktiarkan. Melalui klassifikasi perseimbangan air yang terdapat di Malaysia yang dapat diperlihatkan dari penyelidikan ini, sebarang perubahan ataupun persamaan dengan hasil-hasil kajian Nieuwolt itu akan dibincangkan. Sebenarnya penyelidikan ini merupakan suatu kajian yang sama dengan yang telah diusahakan oleh Nieuwolt tetapi ia lebih panjang tempoh jangka masa kajiannya dan stesyen-stesyen di Sabah dan Sarawak juga dimasukkan di dalam kajian ini. Selain daripada itu,

penyelidikan ini telah menggunakan kedua-dua kaedah Thornthwaite dan Penman dalam pengiraan sejatan dan perseimbangan air di Malaysia sedangkan kajian Nieuwolt cuma menggunakan kaedah Thornthwaite sahaja.

Adalah diharapkan oleh sipengkaji, maklumat-maklumat yang dapat dihasilkan daripada penyelidikan ini akan mencetuskan minat pada para perancang dan pembuat keputusan mengenai kepentingannya sejatan dan perseimbangan air di dalam sebarang projek yang dilaksanakan. Selain daripada itu, kefahaman mengenai sejatan dan perseimbangan air di sesuatu kawasan juga dapat membantu manusia mengeksploitasikan sumber-sumber airnya secara optimum sambil hidup di dalam lingkungan had-had alam semulajadi.

Abstract

Evaporation, in terms of the hydrological cycle, is the conversion of water from the liquid or solid state into vapour, and its diffusion into the atmosphere. A vapour-pressure gradient between the evaporating surface and the atmosphere and a source of energy are necessary for evaporation. Solar radiation is the main source of energy and sets the broad limits of evaporation whilst a large number of meteorological factors such as the temperature of the evaporating surface, vapour-pressure gradient, wind and air turbulence influence the process in a complex web of relationship. In the tropics, the key issue is that given an adequate supply of water, evaporation is high. Expressed in another way, the evaporative demand of the atmosphere is high and this makes water a particularly critical resource in the tropics.

Seasonal variation in rainfall and evaporation can be illustrated by means of simple water balance studies which seek to quantify the difference between precipitation and streamflow due to the evaporation of water from plants and from free water surfaces of rivers and lakes. In fact, water resources assessment of a watershed budget centers on the direct estimation of vapour losses by plant water use. Both Penman in Britain and Thornthwaite in the USA have published evidence that when water is in free supply, the evaporation and transpiration rates from a complete canopy of green vegetation can be predicted directly from climatic factors. Henceforth, the direct computation of plant water use in an area is made possible. Thornthwaite (1968) used only the most widely available data of air temperature and day length whilst Penman (1948) combined a quantitative budget of the incoming solar radiation, the heat used for evaporation, the back radiation and the heating of the surroundings, with an estimate

of the ability of the atmosphere to carry off the water vapour thus produced.

This study seeks to study the level of evaporation and water balance of 15 major weather stations in Malaysia during the period of 1971-1980 with the aim to classify the types of water balances found in Malaysia. Both the Thornthwaite and Penman's methods are used in the computation of the potential evapotranspiration rates in all these stations. It was found that four major types of water balance exist in Malaysia in which certain characteristic features serve to distinguish one from the other. Basically, the four main types of water balances recognized in Malaysia are the west coast type, the east coast type, the inland type and the East Malaysian type. It was also found that in Peninsular Malaysia, the different types of water balance correspond very well with the rainfall regions as worked out by Dale (1959). Though there is, in some areas, a considerable difference between computed values according to the two methods of Penman and Thornthwaite, the general picture of evaporation in Malaysia remains the same. Furthermore, this study shows that although the Thornthwaite's method of computing potential evapotranspiration gives comparable values with those of Penman's, it was not able to show the full extent of the variation of evaporation from month to month. An overall view of the water balances of Malaysia based on long term averages fail to illustrate the important effect of short term rainfall variability. However, month-to-month balances drawn for individual years show considerable departures from the average conditions.

A comparision between the results of this research with those of Nieuwolt (1965) on the evaporation and water balances in Malaya between the period of 1957-1962 failed to show much difference. In fact, it was found that the different types of water balances classified by both studies are similiar in nature, except that this study has excluded Singapore

from its research and has included instead the two East Malaysian states of Sabah and Sarawak. Henceforth, Nieuwolt's study has recognized another water balance known as the Singapore type which is excluded from this study whilst this study has instead discovered another type of water balance that of the East Malaysian states. Notwithstanding these two differences which have resulted from incorporating different study areas, both studies have shown to be concurrent in their findings.

In many countries the study of evaporation is a neglected part of climatology. In Malaysia, where a surplus of precipitation over evaporation prevails during most of the year, interest in evaporation in relation to agriculture and water supply has naturally remained limited. However, exceptionally low precipitation figures and rapid increases in water consumption for potable and industrial purposes have, in the past few years, created severe water shortages in Penang, Kedah, Malacca, Kelantan and other parts of the country. This author hopes that this research will contribute towards increasing awareness of the importance of water balance studies and the realization of the great value of these estimates in optimum utilization of our water resources. This goes on record that basically most of the water resources problems of Malaysia is not the hazards of nature but rather failure on our part to manage them wisely. Measurements and computations of water losses by evaporation under equatorial conditions and in relation to tropical crops will serve to enable us to exploit our water resources to its fullest capacity and yet live within the constraints set by nature. Thus, evaporation and water balance studies are an essential step towards planning a optimum utilization of our resources in bringing about rational development - for the good of the nation and its people.

Abstrak

Sejatan, jika dipandang dari segi kitar air, adalah perubahan air daripada keadaan cecair atau pepejal kepada wap, dan diffusinya ke dalam atmosfera. Untuk sejatan ini berlaku, mesti wujudnya suatu kecerunan tekanan wap di antara permukaan dari mana penyejatan itu berlaku dengan atmosfera serta adanya suatu sumber tenaga. Bahangan matahari merupakan sumber tenaga ini yang utama dan menentukan had-had sejatan itu sedangkan faktor-faktor meteorologikal yang lain seperti suhu permukaan di mana sejatan itu berlaku, kecerunan tekanan wap, kisaran angin dan udara mempengaruhi proses ini dalam suatu rantaian hubungan yang kompleks. Di kawasan tropik, isu yang utama ialah jika terdapatnya bekalan air yang mencukupi, kadar sejatan adalah tinggi. Dengan kata lain, keperluan sejatan atmosfera adalah tinggi dan hakikat ini menjadikan air sesuatu sumber yang sungguh kritikal pada kawasan tropik.

Perbezaan di antara air hujan dengan sejatan dapat dinyatakan melalui kajian-kajian perseimbangan air yang mudah yang cuba menyatakan secara kuantitatif perbezaan di antara kerpasan dengan air lari akibat sejatan air daripada tumbuh-tumbuhan dan permukaan air sungai dan tasik yang bebas. Sebenarnya, penilaian sumber-sumber air dalam belanjawan air sesuatu lembangan berkisar di atas penganggaran yang tepat mengenai kehilangan wap akibat penggunaan air oleh tumbuh-tumbuhan. Keduan-duanya Penman di Britain dan Thornthwaite di Amerika Syarikat telah menerbitkan bukti-bukti bahawa jika bekalan air tidak terhad, kadar sejatan dan perpeluhan daripada sesuatu kanopi tumbuh-tumbuhan hijau yang lengkap dapat diramalkan secara langsung daripada faktor-faktor iklim. Oleh itu, pengiraan secara langsung penggunaan air oleh tumbuh-tumbuhan di sesuatu kawasan dapat diperolehi. Dalam hal ini, Thornthwaite (1968) menggunakan hanya data-data suhu udara dan panjangnya waktu siang yang biasa diper-