刘景植 主编

水利水电类专业英语

系列专业英语

ENGLISH

FOR HYDRAULIC AND HYDROELECTRIC ENGINEERING

武汉大学出版社

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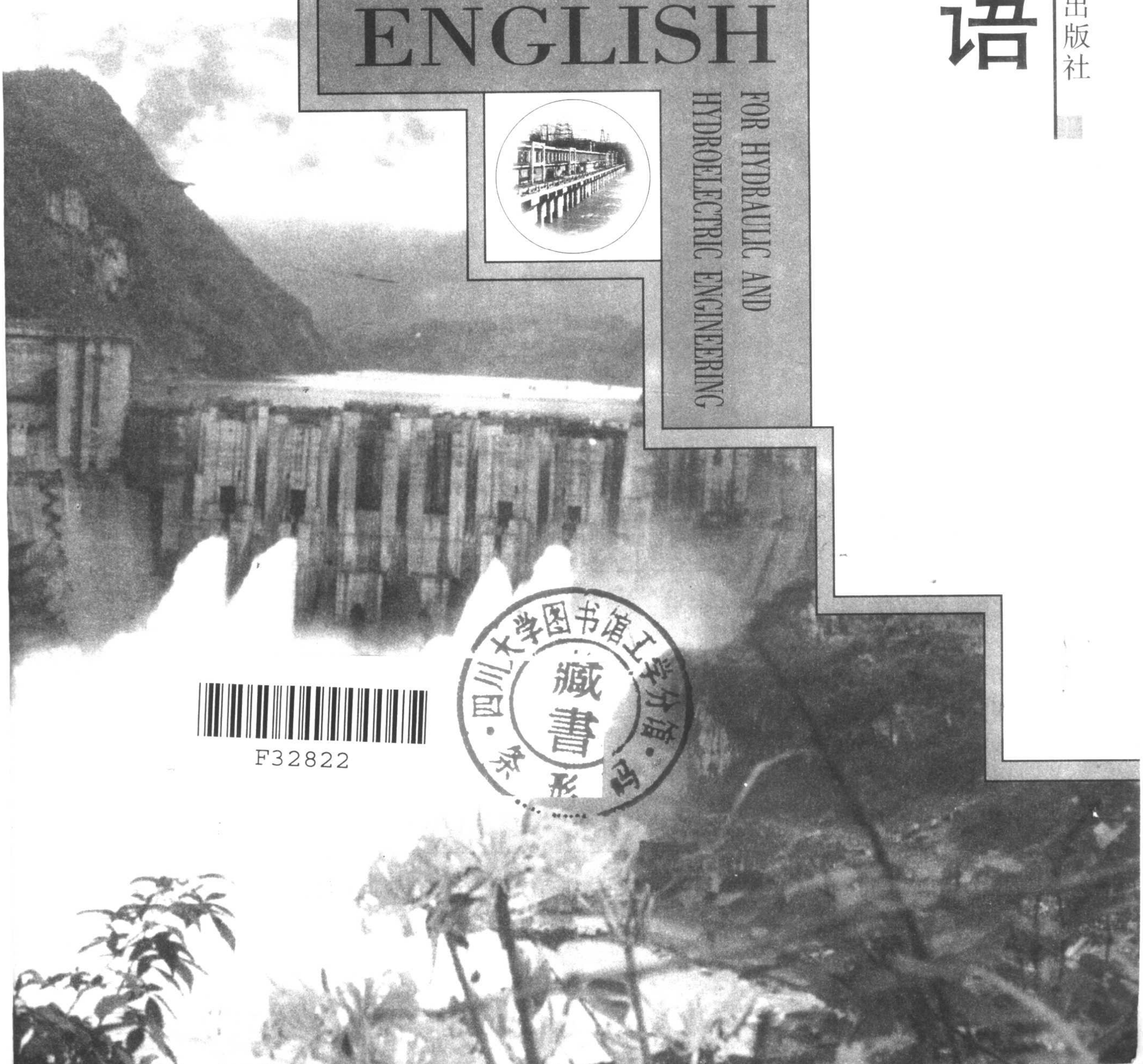

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前　言

当前，水利水电科学技术发展十分迅速，为了了解、学习和借鉴国外先进的科学技术，为我国的社会主义建设服务，需要大量地阅读和翻译国外科技文献及资料。另外，近年来我国在水利水电建设中从国外引进了大批先进的技术和设备，为了学习这些新技术和装好、用好、管理好这些新设备，需要详细地阅读和翻译引进的技术资料和设备的技术说明文件。同时，为了把我国水利水电工程建设和管理的成功经验介绍到国外，也需要有熟练的专业英语知识。要提高水利水电类专业科技英语的阅读和翻译能力，除需要掌握英语语法的基本知识、基本词汇和具有相当广泛的专业知识之外，还需要熟悉专业词汇和科技英语中的一些常用词、词组或短语，熟悉科技英语常见的句型和文体，以及掌握翻译科技文献的基本技巧。

本教材旨在帮助学生和相关人员提高阅读或翻译水利水电类专业科技英语文献及资料的能力，希望通过本书的学习能够达到以下几个目的：

1. 使学生熟悉典型的科技英语句型、文体。
2. 使学生掌握科技英语文献翻译的基本技巧。
3. 为学生提供一部分专业英语词汇和常用词组及短语。

本书的目的仅在于介绍英语的语言特点，并非介绍工程技术本身，这一点务必请读者理解。

本书由刘景植主编。书中Ⅰ. 由郭生练编写，Ⅱ. 由傅湘编写，Ⅲ. 1～8 由黄介生编写，Ⅲ. 9～16 由蔡树英编写，Ⅲ. 17～18 由刘景植编写，Ⅳ. 1～10 由陈胜宏以及陈尚法、徐明毅、傅少君、汪卫明、夏怀孝、吴俊等编写，Ⅳ. 11～14 由夏富洲编写，Ⅴ. 由贺昌海编写，Ⅵ. 1～8 由伍鹤皋编写，Ⅵ. 9～15 由于波编写，Ⅶ. 由吴卫民和余明辉编写。本书在选材过程中还得到了袁宏源教授和李义天教授的审核和指导。

本书的出版得益于原武汉水利电力大学“211 工程”办公室、师资办公室以及水利水电学院的大力帮助和支持，在此表示衷心感谢！

由于水平所限，书中的错误和不当之处恳请批评指正。

编　者

2000.12.

目 录

I HYDROLOGY AND WATER QUALITY

1 Hydrological Cycle and Budget

Hydrology is an earth science. It encompasses the occurrence, distribution, movement, and properties of the waters of the earth and their environmental relations. Closely allied fields include geology, **climatology, meteorology** and **oceanography**.

climatology *n.* 气候学
meteorology *n.* 气象学
oceanography *n.* 海洋学

The hydrologic cycle is a continuous process by which water is transported from the oceans to the atmosphere to the land and back to the sea. Many sub-cycles exist. The evaporation of inland water and its subsequent precipitation over land before returning to the ocean is one example. The driving force for the global water transport system is provided by the sun, which furnishes the energy required for evaporation. Note that the water quality also changes during passage through the cycle; for example, sea water is converted to fresh water through evaporation.

The complete water cycle is global in nature. World water problems require studies on regional, national, international, continental, and global scales. *Practical significance of the fact that the total supply of fresh water available to the earth is limited and very small compared with the salt water content of the oceans has received little attentionl.*[①] Thus waters flowing in one country cannot be available at the same

① 句中，that 引导出同位语从句，从句中的 compared with the salt water content of the oceans 为过去分词短语，说明 frash water 与 salt water 的对比，而主句的谓语 has received 则放在句末。该句译为：地球上可用的淡水资源与海洋咸水相比，不仅是有限的，而且要少得可怜，这个重要的现实尚未得到人们足够关注。

time for use in other regions of the world. Modern hydrologists are obligated to cope with problems requiring definition in varying scales of significant order of magnitude difference. In addition, developing techniques to control weather must receive careful attention, since climatological changes in one area can profoundly affect the hydrology and therefore the water resources of other regions.

Because the total quantity of water available to the earth is finite and **indestructible**, the global hydrologic system may be looked upon as closed. Open hydrologic subsystems are abundant, however, and these are usually the type analyzed. For any system, a water budget can be developed to account for the hydrologic components.

indestructible *a.* 不可避免的

Figures 1 and 2 show a hydrologic budget for the **coterminous** United States. These figures illustrate the components of the water cycle with which a hydrologist is concerned. In a practical sense, some hydrologic region is dealt with and a budget for that region is established. Such regions may be topographically defined (**watersheds** and river basins are examples), politically specified (e.g. county or city

coterminous *a.* 相邻的，边界的

watershed *n.* 流域

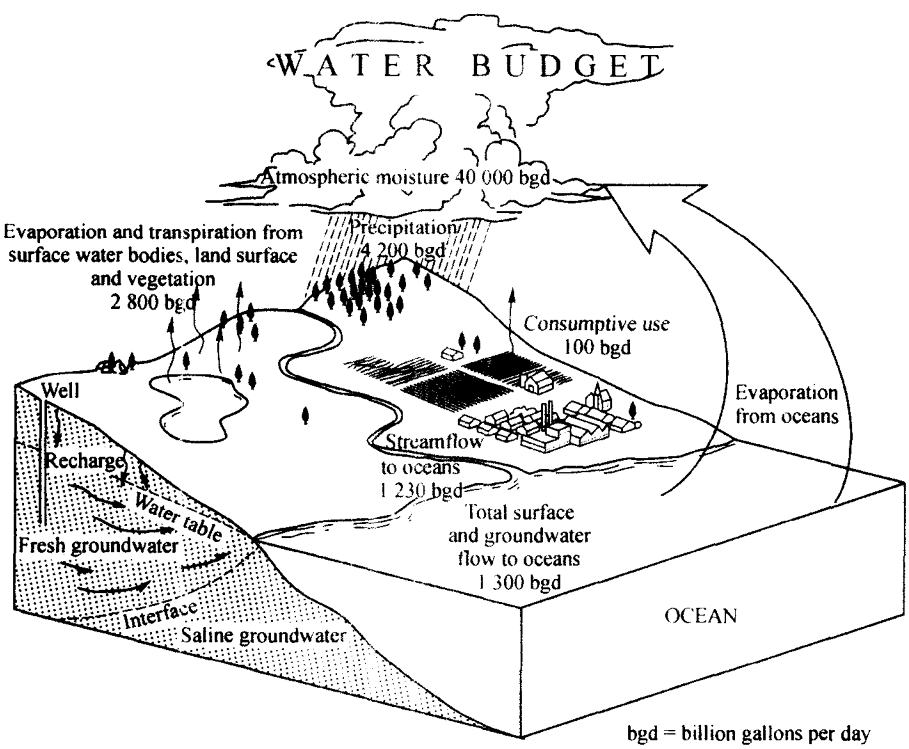

Figure 1 Hydrologic budget of coterminous United States(U.S.Geological Survey)

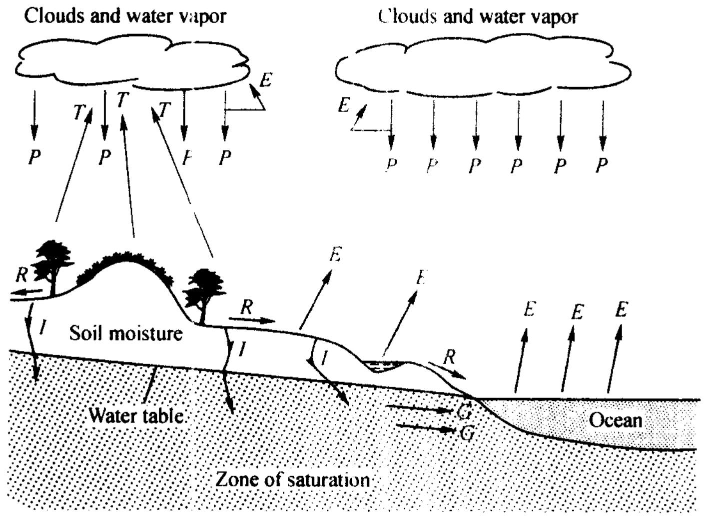

Figure 2 The hydrologic cycle: *T*, transpiration; *E*, evaporation; *P*, precipitation; *R*, surface runoff; *G*, groundwater flow; and *I*, infiltration.

limits), or chosen on some other grounds. Watersheds or **drainage** basins are the easiest to deal with since they sharply define surface water boundaries. These topographically determined areas are drained by a river/stream or system of connecting rivers/streams such that all outflow is discharged through a single outlet.Unfortunately, it is often necessary to deal with regions that are not well suited for tracking hydrologic components. For these areas, the hydrologist will find hydrologic budgeting somewhat of a challenge.

drainage *n.* 排水，排水区

The primary input in a hydrologic budget is precipitation. Some of the precipitation (e.g. rain, snow, hail) may be **intercepted** by trees, grass, other vegetation, and structural objects and will eventually return to the atmosphere by evaporation. Once precipitation reaches the ground, some of it may fill **depressions** (become depression storage), part may penetrate the ground (**infiltrate**) to **replenish** soil moisture and groundwater reservoirs, and some may become surface runoff,that is , flow over the earth's surface to a defined channel such as a stream.

intercept *v.* 截留

depression *n.* 洼地

infiltrate *v.* 渗透

replenish *v.* 再补充

Water entering the ground may take several paths. Some may be directly evaporated if adequate transfer from the soil to the surface is maintained. This can easily occur where a high groundwater table (free water surface) is within the limits of **capillary** transport to the ground surface. Vegetation using soil moisture or ground water directly can also transmit infiltrated water to the atmosphere by a process known as transpiration. Infiltrated water may likewise replenish soil moisture de-

capillary *n.* 毛细管（现象）

ficiencies and enter storage provided in groundwater reservoirs, which in turn maintain dry weather stream flow. Important bodies of groundwater are usually flowing so that infiltrated water reaching the **saturated** zone may be transported for considerable distances before it is discharged. Groundwater movement is subject, of course, to physical and geological constraints.

saturate *v.* 饱和

Water stored in depressions will eventually evaporate or infiltrate the ground surface. Surface runoff ultimately reaches minor channels (gullies, rivulets, and the like), flows to major streams and finally reaches an ocean. Along the course of a stream, evaporation and infiltration can also occur.

2 Unit Hydrographs

Ways to predict flood peak discharges and discharge hydrographs from rainfall events have been studied intensively since the early 1930s. One approach receiving considerable use is called the unit hydrograph method. It derives from a method of unit graphs employed by Sherman, in 1932. The unit graph is defined as follows: *if a given X-hour rainfall produces a* 10 cm *depth of runoff over the given drainage area, the hydrograph showing the rates at which the runoff occurred can be considered a unit graph for that watershed.*[①]

It is incorrect to describe a unit hydrograph without specifying the duration, *X* of the storm that produced it. An *X*-hour unit hydrograph is defined as a direct runoff hydrograh having a 10 cm. Volume and resulting from an *X*-hour storm having a steady intensity of 10/*X* cm/hr. A 2-hr unit hydrograph would be that produced by a 2-hr storm during which 10 cm of excess runoff was uniformly generated over the basin. A 1-day unit hydrograph would be produced by a storm having 10 cm of excess rain uniformly produced during a 24-hr period. The value *X* is often a fraction of 1 hr.

Application an X-hour unit graph to design rainfall excess amounts other than 10 cm *is accomplished simply by multiplying the rainfall excess amount by the unit graph ordinates, since the runoff ordinates for a given duration are assumed to be directly*

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① 该句译为：如果在给定的 *X* 小时内，流域上均匀地产生了 10 cm 的径流深，则在该流域出口断面形成的地面径流过程线即为单位线。

*proportional to rainfall excess*① A 3-hr storm producing 20 cm of net rain would have runoff rates 2 times the values of the 3-hr unit hydrograph. 5 cm in 3 hr would produce flows half the magnitude of the 3-hr unit hydrograph. This assumption of proportional flows applies only to equal duration storms.

If the duration of another storm is an integer multiple of *X*, the storm is treated as a series of end to end *X*-hour storms. First, the hydrographs from each *X* **increment** of rain are determined from the *X*-hour unit hydrograph. The ordinates are then added at corresponding times to determine the total hydrograph.

increment *n.* 增加，增量

Implicit in deriving the unit hydrograph is the assumption that rainfall is distributed in the same **temporal** and **spatial** pattern for all storms. This is generally not true; consequently, variations in ordinates for different storms of equal duration can be expected.

temporal *a.* 时间的
spatial *a.* 空间的

The construction of unit hydrographs for other than integer multiples of the derived duration is facilitated by a method known as the S-hydrograph. The procedure employs a unit hydrograph to form an S-hydrograph resulting from a continuous applied rainfall. The unit hydrograph theory can be applied to **ungauged watersheds** by relating unit hydrograph features to watershed characteristics. As a result of the attempted synthesis of data, these approaches are referred to as **synthetic unit hydrograph** methods. The need to alter duration of a unit hydrograph encouraged studies to define the shortest possible storm duration,that is, an instantaneous unit rainfall. The concept of **instantaneous unit hydrograph** (IUH) can be used in construction unit hydrographs for other than the derived duration.

ungauged watershed 无水文测站流域（或无水文资料流域）
synthetic unit hydrograph 综合单位线
instantaneous unit hydrograph 瞬时单位线

Methods of deriving unit hydrographs vary and are subject to engineering judgment. The level of sophistication employed to **unravel** the problem depends largely on the kind of issue in question. Several methods useful in the determination of unit hydrographs will be discussed. They are subdivided into starting with unit hydrographs obtained from field data and manipulating them by S-hydrograph methods and constructing synthetic unit hydrographs.

unravel *v.* 解释，阐明

Data collection preparatory to deriving a unit hydrograph for a

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① 该句译为：采用 *X* 小时的单位线来计算并非等于 10 cm 的径流过程，可简单地用净雨深乘以单位线的纵标，因为对一个给定时段，单位线假定径流与净雨直接成比例。

gauged watershed can be extremely time consuming. To develop a unit hydrograph, it is desirable to acquire as many rainfall records as possible within the study area to ensure that the amount and distribution of rainfall over the watershed is accurately known. Preliminary selection of storms to use in deriving a unit hydrograph for a watershed should be restricted to the following:

gauged watershed 有水文测站流域（有水文资料流域）

1) Storms occurring individually, that is, simple storm structure.

2) Storms having uniform distribution of rainfall throughout the period of rainfall excess.

3) Storms having uniform spatial distribution over the entire watershed.

These restrictions place both upper and lower limits on size of the watershed to be employed. An upper limit of watershed size of approximately 2 000 km^2 is overcautious, although general storms over such areas are not unrealistic and some studies of areas up to 3 000 km^2 have used the unit hydrograph technique. The lower limit of watershed extent depends on numerous other factors and cannot be precisely defined. A general rule of thumb is to assume about 10 km^2. Fortunately, other hydrologic techniques help resolve unit hydrographs for watersheds outside this range.

The preliminary **screening** of suitable storms for unit hydrograph formation must meet more restrictive criteria before further analysis:

screen *v.* 筛选

1) Duration of rainfall event should be approximately 10% - 30% of the drainage area **lag time**.

lag time 滞时

2) Direct runoff for the selected storm should be greater than 5 cm.

3) A suitable number of storms should be analyzed to obtain an average of the ordinates for a selected unit hydrograph duration. Modifications may be made to adjust unit hydrograph durations by means of S-hydrographs or IUH procedures.

4) Direct runoff ordinates for each storm should be reduced so that each event represents 10 cm of direct runoff.

5) The final unit hydrograph of a specific duration for the watershed is obtained by averaging ordinates of selected events and adjusting the result to obtain 10 cm of direct runoff.

Construction the unit hydrograph in this way produces the integrated effect of runoff resulting from a representative set of equal duration storms. Extreme rainfall intensity is not reflected in the determination. If intense storms are needed, a study of records should be made to ascertain their influence upon the discharge hydrograph by comparing peaks obtained utilizing the derived unit hydrography and actual hydr0graphs form intense storms.

Essential steps in developing a unit hydrograph for an isolated storm follow :

1) Analyze the stream flow hydrograph to permit separation of surface runoff from groundwater flow.

2) Measure the total volume of surface runoff (direct runoff) from the storm producing the original hydrograph equal to the area under the hydrograph after groundwater base flow has been removed.

3) Divide the ordinates of direct runoff hydrograph by total direct runoff volume in inches and plot these results versus time as unit graph for the basin.

4) Finally, the effective duration of the runoff-producing rain for this unit graph must be found from the **hyetograph** (time history of rainfall intensity) of the storm used.

hyetograph *n*.雨量计图

Procedures other than those listed are required for complex storms or in developing synthetic unit graphs when few data are available. Unit hydrographs can also be transposed from one basin to another under certain circumstances

3 Flood Routing

Flood forecasting, reservoir design, watershed simulation, and comprehensive water resources planning generally utilize some form of routing technique. Routing is used to predict the temporal and spatial variations of a flood wave as it **traverses** a river reach or reservoir, or it can be employed to predict the outflow hydrograph from a watershed subjected to a known amount of precipitation. Routing techniques may be classified into two categories - hydrologic routing and hydraulic routing.

traverse *v*. 经过，流过

Hydrologic routing employs the equation of continuity with either an analytic or an assumed relation between storage and discharge within the system. Hydraulic routing, on the other hand, uses both the equation of continuity and the equation of motion, **customarily** the momentum equation. This particular form utilizes the partial differen-

customarily *adv*. 通常地，习惯地

tial equations for unsteady flow in open channels. It more adequately describes the dynamics of flow than does the hydrologic routing technique.

Applications of hydrologic routing techniques to problems of flood prediction, evaluations of flood control measures, and assessments the effects of **urbanization** are numerous. Most flood warning systems incorporate this technique to predict flood stages in advance of a severe storm. It is the method most frequently used to size **spillways** for small, intermediate, and large dams. Additionally, the synthesis of runoff hydrographs from gauged and ungauged watersheds is possible by the use of this approach.

urbanization *n.* 城市化，都市化

spillway *n.* 溢洪道

Hydrologic river routing techniques are all founded upon the equation of continuity

$$I - O = \frac{dS}{dt} \tag{1}$$

where I is the inflow rate to the reach, O is the outflow rate from the reach, dS/dt is the rate of change of storage within the reach.

Storage in a stable river reach can be expected to depend primarily on the discharge into and out of a reach and on hydraulic characteristics of the channel section.[①] The storage within the reach at a given time can be expressed as

$$S = \frac{b}{a}\left[XI^{m/n} + (1-X)O^{m/n}\right] \tag{2}$$

Constants a and n reflect the stage discharge characteristics of control sections at each end of the reach, and b and m mirror the stage-volume characteristics of the section. The factor X defines the relative weights given to inflow and outflow for the reach.

The Muskingum method assumes that $m/n = 1$ and lets $b/a = K$, resulting in

$$S = K[XI + (1-X)O] \tag{3}$$

where K is the storage time constant for the reach, X is a weighting factor that varies between 0 and 0.5.

Application of this equation has shown that K is usually rea-

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① 句中，不定式 to depend 后连着两个用 on 引导的介词短语。该句译为：稳定河段中的蓄水量主要取决于该河段的入流和出流，以及河渠断面的水力特征值。

sonably close to the wave travel time through the reach and X averages about 0.2.

Behavior of the flood wave due to changes in the value of the weighting factor X is readily apparent. The resulting downstream flood wave is commonly described by the amount of translation, that is, the time lag and by the amount of attenuation or reduction in peak discharge. The value $X = 0.5$ results in a pure translation of the flood wave.

Application of Eqs.(1) and (3) to a river reach is a straightforward procedure if K and X are known. The routing procedure begins by dividing time into a number of equal increments, Δt, and expressing Eq. (1) in finite difference form, using subscripts 1 and 2 to denote the beginning and ending times for Δt. This gives

$$\frac{I_1 + I_2}{2} - \frac{O_1 + O_2}{2} = \frac{S_2 - S_1}{\Delta t} \tag{4}$$

The routing time interval Δt is normally assigned any convenient value between the limits of $K/3$ and K.

The storage change in the river reach during the routing interval from Eq.(3) is

$$S_2 - S_1 = K[X(I_2 - I_1) + (1 - X)(O_2 - O_1)] \tag{5}$$

and substituting this into Eq. (4) results in the Muskingum routing equation

$$O_2 = C_0 I_2 + C_1 I_1 + C_2 O_1 \tag{6}$$

in which

$$C_0 = \frac{-KX + 0.5\Delta t}{K - KX + 0.5\Delta t}$$

$$C_1 = \frac{KX + 0.5\Delta t}{K - KX + 0.5\Delta t}$$

$$C_2 = \frac{K - KX - 0.5\Delta t}{K - KX + 0.5\Delta t}$$

Note that K and Δt must have the same time units and also that the three coefficients sum to 1.0.

Theoretical stability of the numerical method is accomplished if Δt falls between the limits $2KX$ and $2K(1-X)$. The theoretical value of K is the time required for an elemental (kinematic) wave to traverse the reach. It is approximately the time interval between inflow and outflow peaks, if data are available. If not, the wave velocity can be estimated for various channel shapes as a function of average velocity V for any representative flow rate Q. Velocity for steady uniform flow can be estimated by either the Manning or Chezy equation.

Since, I_1 and I_2 are known for every time increment, routing is accomplished by solving Eq.(6) for successive time increments using each O_2 as O_1 for the next time increment.

4 Water Quality Models

Because water quality is **inextricably** linked to water quantity, it is important for the hydrologist to understand the significance of developing modeling techniques that can accommodate both features.

inextricably *a.* 不可避免的

A water quality model is a mathematical statement or set of statements that equate water quality at a point of interest to **causative** factors. In general, water quality models are designed to (1) accept as input, constituent **concentration** versus time at points of entry to the system, (2) simulate the mixing and reaction kinetics of the system, and (3) synthesize a time-distributed output at the system outlet.

causative *a.* 引起……的

concentration *n.* 浓度

Either stochastic (containing probabilistic elements) or deterministic approaches may be taken in developing methods for predicting pollutional loads. The former technique is based on determining the likelihood (frequency) of a particular output quality response by statistical means. This is similar to frequency analysis of floods or low flows. Water quality records should be available for at least 5 years (and preferably much longer) if estimates of return periods for infrequent events are to be reliable.

The deterministic approach (output explicitly determined for a given input) requires that a model be developed to relate water quality loading to a known or assumed hydrologic input. *Such a model can range from an empirical concentration discharge relation to a physical equation representing the hydrochemical cycle.* The ultimate modeling technique is that which best defines the actual mechanism

① 句中，介词 to 不是与 relation 相联系，而是 from...to...结构。该句译为：这样的一个模型可以从一个浓度流量的经验关系到一个物理方程，表达和描述水化学循环。