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SELECTED BIBLIOGRAPHY ON
EROSION AND SILT MOVEMENT

BY

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Research and Statistical Division of the
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INTRODUCTION

ADMINISTRATION AND SUPERVISION

A project for studies of floods and other hydrologic phenomena was established in New York City in November 1935 under the Research and Statistical Division of the Works Progress Administration for New York City. The project was sponsored by the College of Engineering, New York University. Quarters and equipment were supplied by the Works Progress Administration, which also attended to administrative details, including the furnishing of technical and clerical personnel and the procurement of supplies. Technical direction and guidance were supplied by the Geological Survey, United States Department of the Interior, and the Soil Conservation Service, United States Department of Agriculture, the former furnishing supervisory personnel and paying their salaries, and the latter paying travel and subsistence costs incident thereto. The program of studies was terminated June 30, 1936.

The Works Progress Administration for New York City operated during this project under the general direction of Victor F. Ridder, administrator. The research and investigational features of the project were conducted with Dean Thorndike Saville, College of Engineering, New York University, as director, and Gordon R. Williams, assistant engineer, Geological Survey, as vice director. Mr. Williams maintained close and continuous contact with the project, and under the general direction of N. C. Grover, chief hydraulic engineer, and R. W. Davenport, chief of the division of water utilization, Geological Survey, was primarily responsible for the conduct of the studies and the supervision of all technical details.

The manuscript and tabulations showing the results of these studies were supplied to the participating agencies. It is understood between these agencies that the results are the property of the Geological Survey.

This report embodies the material gathered as one of the items of this program, which covered the preparation of a bibliography of works in foreign languages on soil erosion, silt movement, and related subjects. This study was suggested by the Soil Conservation Service. It utilized the special linguistic knowledge of some members of the staff of available workers in a way that was believed to have substantial value.

The references, annotations, abstracts, and indexes included in this bibliography as first prepared in New York City have been subjected to a careful and extensive checking against original sources and have been rewritten in part by Mr. Williams, who used the library facilities afforded by the various organizations of the Government in Washington, D. C. The responsibility for the accuracy and authenticity of the references of this bibliography therefore rests very largely on Mr. Williams.

ACKNOWLEDGMENTS

Members of the staff of the Water Resources Committee of the National Resources Committee contributed greatly in the initiation of this project and in effecting an arrangement for the participation therein of the Geological Survey and the Soil Conservation Service. Dean Thorndike Saville, College of Engineering, New York University, maintained a stimulating and sympathetic relationship in the supervision of the project. C. S. Jarvis, hydraulic engineer, Soil Conservation Service, served as a consultant and as such kept in close contact with the progress of the studies and from the background of his extensive knowledge of hydrology rendered valuable assistance.

The successful conduct of the work was facilitated by the cooperative attitude of the administrative officials of the Works Progress Administration, especially of Robert C. Urban, the administrative project supervisor.

Acknowledgment for the helpful and cooperative attitude of the technical and clerical personnel organized for the conduct of these studies is hereby expressed. Especially appreciative acknowledgment is accorded to Gustav Neumann, whose linguistic knowledge and studiousness contributed in a most essential way to the development of the material presented in this bibliography. It is particularly worthy of note that Mr. Neumann initially prepared much of the material in the section entitled "Descriptive and historical notes", the abstracts of papers and articles, and the vocabularies of technical words in French, German, and Russian.

DESCRIPTIVE AND HISTORICAL NOTES

The erosional history of the earth's surface constitutes a most essential part of the sciences of geology and hydrology, and hence the broad aspects of water erosion and the disposition of eroded materials have been studied since the birth of these sciences. Evidence of measures for combating water erosion of soil by modern and probably ancient civilizations in other lands shows that man has long been concerned with the effects of this process and has developed a practical protective technique. It is natural that the rapid extension of a use and a culture to the lands of our country radically different from those to which they had been adapted through the ages should disturb the established equilibrium of the soil and through accelerated erosion start a chain of processes of readjustment of the land surface, often with radical and disastrous consequences. The growing activity in the utilization and control of our rivers has increasingly focused attention on the incidents of river behavior that have to do with erosion and silt movement. In dealing with these problems we have drawn upon the experience of older lands for guidance, and the extensive citation of foreign references in the earlier papers treating these subjects, such as Hooker's "The suspension of solids in flowing waters",[1] published in 1896, and Gilbert's "The transportation of debris by running water",[2] published in 1914, is particularly significant.

From the long period covered (1753 to 1936) and from the variety of incidental subjects included it will be easily understood that the bibliography here presented is distinctly selective; however, 455 books and papers were covered. The names of 133 periodicals that were consulted are listed on pages 42–45.

After a rough general survey of the field it seemed appropriate to undertake:

1. A bibliographic framework covering the various phases and stages of erosion and silting from field and mountain to river delta.
2. The creation of a nucleus of abstracts on the basis of which the users of this bibliography might judge whether or not it would be worth while to elaborate on such a framework by enlarging this nucleus as well as by keeping both the bibliography and the abstracts up to date.
3. To save certain byproducts of the research in the form of the appended vocabularies of French, German, and Russian terms. These vocabularies may be of service to those who want to extend the work or to investigate further some of the entries. It is, of course, obvious that a general knowledge of the respective languages and a fair knowledge of the subjects are prerequisites for those expecting to derive any benefit from these vocabularies. Although they are intended to include principally terms that are not readily found, even in the available technical dictionaries, some pertinent common words have been inserted for the convenience of the eventual users.

An alphabetic list of publications referred to in the bibliography is supplemented by entry numbers to facilitate the selection of a list

[1] Am. Soc. Civil Eng. Trans., vol. 36, pp. 239–340, 1896.
[2] Geol. Survey Prof. Paper 86, 1914.

for further investigation. A practically complete list will be found in "A world list of scientific periodicals published in the years 1900–33," 2d edition, London, Oxford University Press, 1934. That list contains about 36,000 entries but unfortunately does not classify the entries by subject or language, so that the extraction from it of the titles of periodicals covering certain special subjects would require considerable time. Although the Oxford list contains all principal Russian periodicals, a more convenient medium for the investigation of Russian literature will be found in Zhournalnai Letopis (Chronicle of Periodicals), which appears twice a month and which for 1935 registered a total of 1,040 periodicals, from which 55,737 Russian articles were listed and classified according to subjects, some of them with brief annotations. Another Russian bibliographic publication of interest is Novoye v Pochvovedenii (News relating to Soil Science), which covers the world literature on the subject of soil. Any given periodical may be located by consulting the "Union list of serials" and its supplements, New York, H. W. Wilson Co., which gives an alphabetic list of periodicals, together with a list of libraries in which each may be found.

Because of the variety of subjects covered by this bibliography and because of its chronologic arrangement, subject and author indexes have been compiled to facilitate the selection of material by subject, by author, chronologically, or by periodicals.

The following previous bibliographies have been utilized as guides in compiling the present work:

1. Bibliography on the subject of transportation of solids by flowing water in open channels, 2 parts, 116 pp., Bur. Reclamation, 1933.
2. Soil erosion and its prevention, partial list, 1900–1934, compiled by D. Graf, Washington, U. S. Dept. Agr., Bur. Agr. Engineering, 1934–35.
3. Bibliography on soil conservation, compiled by Lillian H. Wieland, revised by June Henderson, 179 pp., Washington, U. S. Dept. Agr., Soil Conservation Service, 1935–36.
4. Collection of bibliographic material on silt in the library of Thorndike Saville, Dean, College of Engineering, New York University.

Because of the danger of errors in work of this kind, it was the policy to check each item taken from other bibliographies, if possible, against the original.

In selecting entries for this bibliography the compilers have held the view that the material chosen should be suitable for use not only by the scientist, the engineer, and the agronomist, but generally for public dissemination of information concerning erosion and silt movement.

In view of the abundant literature in the English language on accelerated agricultural soil erosion, the apparent scarcity of such literature in foreign languages is rather surprising. If the explanation of such a scarcity is to be based on the material reviewed for the present work, the apparent causes may be classified as follows:

1. A combination of geomorphic, climatic, and hydrologic conditions in some countries, which seem to prevent erosion from becoming a menace (see entry 432).

2. The establishment of properly regulated crop rotations.

3. Programs of reforestation and afforestation and strict measures controlling deforestation.

4. The establishment of beneficial regulation of streams.

5. Apparent unconcern on the part of certain governments toward investigating the matter, and an inclination to let the farmer look out for his own interests.

6. Sufficient land area for shifting agricultural operations as the cultivated lands deteriorate.

7. Long-established methods of erosion control, as in regions around the Mediterranean Sea, where terrace building and maintenance have been carried on for centuries as the only possible method for eking out a living, or, as in the Vosges, where, after the harvest, soil must be carried back from the bottom terrace to the top terrace (see entry 441).

Nevertheless, there are indictions that an extensive search of foreign-language literature may yield many additional items on agricultural erosion.

The entries on silt movement and river regulation are relatively numerous and cover field investigations as well as small-scale studies in hydraulic laboratories. The abundance of items on this subject is apparently explained by the fact that the struggle against silt has been waged by resourceful navigation and water-power interests and road-building agencies.

The attitude of the principal nations toward erosion problems in general, as evidenced by the publications examined for this bibliography, may be characterized as follows:

France.—The extensive afforestation programs carried on in France seem to proceed in accordance with the poetic formulas recorded by L. A. Fabre (see entry 155):

> The earth denuded struggles against water.
> The earth armed with vegetation struggles for water.
> He who would master water must master the mountains.
> Spontaneous vegetation everywhere protects against erosion.

Italy.—Stresses the importance of artificial lakes.

Switzerland.—Is interested mainly in controlling mountain torrents.

Germany.—Seems at present to hold that the interests of the farmer have received little recognition as compared with those of power and navigation organizations and large land-owners. Erosion does not seem greatly to worry Germany. Her concern seems to be in regard to irrigation and eventual completion of national water control (see entry 439) and a national soil-protection law (see entry 420).

Austria.—Seems to follow France with an extensive afforestation program.

Russia.—Calls attention to sheet erosion ("the secret plague of agriculture") as found in certain sections (see entry 385). Within the broad expanse of the country a wide variety of conditions may be found. At present silt problems receive more attention, because of the extensive power-plant construction and canal building. In studying these silt problems the Russian engineers subject all former theories and formulas, of whatever origin, to critical examination (see entry 448) and with extensive laboratory and field research try to solve the problems in their own way (see entries 401, 406). Some investigators seem to consider that "without the solution of the turbulence problem all our hydraulics represent only a collection of empirical formulas not connected by any strict system" (see entry 396).

Sweden.—Appears to have collected systematic and comprehensive data on denudation (see entries 362, 434).

South America.—Appears to have plenty of open spaces for advancing the agricultural frontier, and only visiting foreigners seem to notice the danger signs of erosion (see entries 372, 394, 441, 450).

Africa, Australia, etc.—The erosion problem is apparently acute in some sections. Information is gleaned mostly from papers written in English.

Europe as a whole and southern and eastern Asia.—It is claimed that with a thousand years of soil cultivation (at least on moderately sloped and carefully cultivated fields) a balance is being approached between the formation of new weathered soil and the denudation by water, wind, and gravity (see entry 441).

Ancient civilizations.—No ancient literature bearing on the subject has been found. Information on erosion in ancient times seems to have been obtained from deductions based on the findings of modern explorers and investigators. An example of this is given in entry 451.

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The following bibliography is arranged chronologically, and the entries under each year are arranged alphabetically by authors, with the anonymous papers at the end.

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1773

2. Silberschlag, Johann, Hydrotechnik oder Theorie des Wasserbaues (Hydrotechnics or the theory of hydraulic engineering), Leipzig, 1773. Copy at Zürich Polytechnikum.

1786

3. Dubuat-Nançay, L. G., Principes d'hydraulique (Elements of hydraulics), 2 vols., 816 pp., Paris, 1786. Quoted by Léon Durand-Claye in Annales des ponts et chaussées, 6e sér., tome 11, pp. 530–531, 1886. Experiments on particles moved by water, flume traction, uniform and turbulent movement of water in rivers, and the resistance of fluids in general. Also quoted in Geol. Survey Prof. Paper 86, pp. 193, 216, 1914.

1797

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1832

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1845

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1846

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1848

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Wasserkraft, München: 276, 293.
Wasserkraft und Wasserwirtschaft, München und Berlin: 344, 366, 405, 420, 424, 433, 448, 454.
Wasserwirtschaft, Wien: 309, 396, 408, 410.
Wasserwirtschaftliche Rundschau, Berlin: 245.
World Power Conference, Transactions: 379.
Zapiski po gidrografii, Petrograd: 297.
Zeitschrift für angewandte Mathematik und Mechanik, Berlin: 284, 321, 339, 343.
Zeitschrift für Bauwesen: 20, 34, 49, 70, 86, 115, 120, 133, 135, 143, 149, 158, 177, 188, 206, 210, 217, 236, 243, 262, 287, 296, 347.
Zeitschrift für das gesamte Turbinenwesen, München und Berlin: 237.
Zeitschrift für Geomorphologie, Leipzig: 328, 372, 392, 394.
Zeitschrift für Gewässerkunde, Dresden: 104, 122, 134, 136, 137, 168, 186, 193, 212, 215.
Zeitschrift für Gletscherkunde, Berlin: 172.
Zeitschrift für Physik, Berlin: 274.
Zeitschrift für praktische Geologie, Berlin: 148, 400, 425.
Zentralblatt der Bauverwaltung, Berlin: 103, 165, 167, 174, 209, 221, 251, 252, 268, 278, 282, 298, 303, 378.

ABSTRACTS

117. Friedrich, Adolf, Die Entwicklung des Kulturingenieurwesens von den ältesten Zeiten bis zur Gegenwart (The development of agricultural engineering from the most ancient times to the present), 87 pp., Wien, K.-k. Hochschule für Bodencultur, 1900.

An interesting collection of data pertaining to hydraulic engineering in ancient times (back to about 4500 B. C.) and covering all parts of the world then known. The material refers mostly to irrigation, drainage, and water supply. On page 18 a brief reference is made to traces of mighty stone dams in Egypt which served as barrages to hold back the debris.

155. Fabre, L. A., L'achèvement de la restauration des montagnes en France (The achievement of mountain restoration in France): Houille blanche, 6e année, pp. 12–18, 1907.

On forest conservation in the mountainous regions of France practiced according to the formula

Le sol dénudé lutte contre l'eau;
Le sol armé par la végétation lutte pour l'eau.
The earth denuded struggles against water;
The earth armed by vegetation struggles for water.

and the other formula

Qui veut être le maître des eaux doit être le maître des montaignes.
La végétation spontanée protège partout le sol contre l'érosion.
Who would master water must master the mountain.
Spontaneous vegetation everywhere protects against erosion.

The recommendation is made that the state should acquire water sources and their immediate surroundings, including unstable lands such as those threatened by landslides and avalanches and the outlets and immediate vicinity of depressions of every kind where water may accumulate.

192. Direction générale des eaux et forêts, Restauration et conservation des terrains en montagne (Restoration and conservation of the mountain terranes), 3 vols., 800 pp., Paris, 1911.

A report to the French Minister of Agriculture with 300 photographs illustrating the work of restoration and conservation in the mountainous regions of France.

A brief historical background of the conservation law of 1882 is given, together with a general consideration of its relation to private and community interests. The contributions to the subject of conservation made by various authors, including Pliny, Bernard Palissy, Fabre, Surell, Cézanne, Scipion Gras, Breton, Mathieu, Costa de Bastelica, and Demontzey are reviewed.

The first volume covers general features, such as precipitation, vegetation, degradation, mountain torrents, restoration, trees and grasses employed in restoration work, the work of reforestation and developing a grass cover, general working methods and measures. Then follows an account of the various areas covered, the expenditures in connection with acquiring lands, and the different kinds of work—from 1860 to 1909. The last chapter covers pasture amelioration.

The second volume gives a summary description of each restoration area (périmètre) in the Alps region, including data on the river basins, geologic conditions, climate, production, administration, population, degree of soil degradation, denudation, and the work accomplished.

The third volume covers in the same way the périmètres of the Pyrenees, the Cevennes, and the central regions.

308. Penck, Walther, Die morphologische Analyse (Morphologic analysis): Geog. Abh., 2. Reihe, Heft 2, 283 pp., Stuttgart, 1924. Bibliography of 182 items.

Morphologic analysis means to Penck a method of investigation of the process of crustal movements starting from the forms of the earth's surface.

In this paper it is shown that the slope formation depends upon erosion. Penck intended to show later how, on the basis of a certain relief type, the process of the crustal movements could be determined. The forms of the earth's surface correspond to the relations between the intensity of the opposing endogenous and exogenous forces.

Structure explains only one part of the crustal movement. The duration and intensity of these processes may be determined only from the shape of the surface. Tectonics and morphology must supplement each other in order to throw light upon the endogenous processes.

Penck treats with considerable detail the weathering of rocks and shows that various kinds of weathering lead to the same ultimate results, and that geologic and climatic differences merely affect the speed of the process.

Denudation, corrosion, and erosion in their relations to the sorting of the weathered material are thoroughly treated.

Erosion baselevel and denudation baselevel are compared. The general and direct erosion bases Penck defines as the determining niveaus (levels) which regulate the work of upstream stretches of rivers and which are located at places where the channel leaves a tectonically uniform plateau and enters an adjoining plateau which is subject to endogenously different movements.

General denudation bases are located where mass movements and surface denudation, including corrosion, cease and along the lines of steadily or occasionally flowing waters.

The problem of slope development is extensively treated, and in relation to the erosion intensity slope development is divided into three kinds—ascending, descending, and uniform. The first leads to convex slope profiles, the second leads to even flatter slopes, and the third produces a balance between erosion and denudation and leads to straight-line slopes.

Penck's deductions are based on numerous observations pertaining to denudation processes and actual forms of the earth's surface.

In referring to theories or deductions of other authors, Penck assumes that the reader is fully familiar with the details of such theories and deductions, so that a fair knowledge of geomorphology is a prerequisite for a complete understanding of this paper.

A more condensed exposition of the Penck deductions may be found in his paper entitled "Wesen und Grundlagen der morphologischen Analyse, reprint from Sächs. Akad. Wiss. Leipzig, Math.-phys. Kl., Ber., Band 72, pp. 65–102, 1920.

319. Kaminsky, A. A., Dannye i mysli o krugovorote vody na zemon share (Data and thoughts pertaining to the hydrologic cycle on the earth): Tsentral'noe gidrometeorologicheskoe bûro Izv. (Central Hydro-meteorologic Bureau Bull.), vypusk 4, pp. 7–22, Leningrad, 1925.

A picture of the gradual development and present status of our knowledge pertaining to the hydrologic cycle. Taking Brückner's figures and applying R. Fritsche's corrections for the precipitation on land and G. Wuest's data on evaporation from the sea, the author obtains the following table:

Annual cycle

	Cubic kilometers
Evaporation from sea	307, 000
Evaporation from land	81, 000
Precipitation on land and sea	388, 000
Evaporation from sea	307, 000
Quantity of vapors transferred to land	30, 000
Precipitation at sea	277, 000
Vapors obtained from sea	30, 000
Evaporation from land which drains to sea	71, 000
Precipitation on land with drainage to sea	101, 000
Evaporation from districts without run-off	10, 000
Precipitation in districts without run-off	10, 000

Compares map of resultant of prevailing winds in the summer with map of average absolute humidity lines and finds that these humidity lines generally bear a definite relation to the directions of the winds from the Baltic Sea.

Kaminsky finds that the transportation of vapors inland is undoubtedly connected with certain elements of the general circulation of the atmosphere.

Suggests the study of the smaller river systems (300 to 500 square kilometers) lying in the general direction of the prevailing winds. One such experimental basin is now already utilized to the south of Lake Ladoga (Lava River).

328. Stiny, Josef, Der Schweb der Mur, Steiermark (Suspended matter in the Mur, Styria): Zeitschr. Geomorphologie, Band 1, Heft 1, pp. 49–53, 1925.

The important data are as follows:

Drainage basin: 5,291 square kilometers.

Annual load of suspended matter: 300,000 metric tons.

Annual denudation by suspended matter alone: 0.034 millimeters (not counting bed load and dissolved minerals) at a density of 1.6.

Requires 29,300 years to lower total surface 1 meter.

Table of observations in 1924 shows radical fluctuations of coarse sand, fine sand, silt, and clay contents, but independent of river stages.

335. Schoklitsch, Armin, Geschiebebewegung in Flüssen und an Stauwerken (Bed-load movement in rivers and at dams), 112 pp., Wien, Julius Springer, 1926.

This book records the results of the author's many years of work. Observations and measurements in the field were carried out with the cooperation of two hydroelectric companies, and the laboratory experiments were made at the laboratories of the technical college at Graz.

The region investigated is that of the Mur River between Bruck and Graz, having the following characteristics:

	Cubic m/sec.
Flow, minimum	30
Flow, maximum high water	1,450
Flow at which bed load starts	150
Withdrawal, maximum	135

The author does not confine himself to his own observations and experiments, but introduces considerable additional data in order to cover each subject thoroughly.

A chapter is devoted to each of the following items:

1. *Characteristics of bed loads.*—Points out that for engineering purposes the graphic representation of grain sizes is most suitable.

2. *Attrition and sorting of bed loads.*—Refers to H. Sternberg's formula for loss of weight proportional to distance traveled; Fugger's and Kastner's tables of attrition coefficients for various rocks; A. Heim's tables for distances traveled and specific attrition for principal rocks; Darcel's tables on petrographic sorting and grain-size sorting on the Seine from Paris downstream; a composite table on specific attrition covering parts of the Rhine, Iller, Mur, and Danube. Attention is called to the scantiness of data on scouring of rocks and structural materials, such as wood. Several interesting cases are cited. The sorting of sediments in sandbars is explained and illustrated.

3. *Movement of bed load and suspended matter in river courses.*—Includes definitions and data on suspended matter. Contains also table of data obtained at 28 stations on various European rivers covering observation periods from 1 to 152 years with particular reference to silting at reservoirs. This table has been reprinted in the author's Wasserbau.

Many tables are given which include results of measurements in various parts of the world, data on turbidity in different parts of the Mur and other German rivers, and figures on velocity as affected by bed load or suspended matter.

4. *Change of bottom within reservoirs and at outlets.*—Silting under different conditions and in various parts of reservoirs is discussed and illustrated.

5. *Selection of outlet location in regard to bed-load movement.*—Illustrates the difference in action between the outlet in line with a straight section of the river and the outlet at a bend, and the resulting silting in each case, and describes the function of the bottom outlet.

6. *Determining the intake sill heights in regard to bed-load movement.*—Points out that the deciding factor is the sill's depth under the surface. Illustrations show the effect of the sill location under different conditions, the resulting silting, etc.

7. *Dimension of the intake cross section in regard to bed-load movement.*—Calls attention to the accepted rule that the cross section must be of such dimension as to affect an intake velocity between 0.5 and 1.5 meters per second, but that the results are not always satisfactory even if this rule is observed. Laboratory experiments assisted in explaining this problem.

8. *Influence of the curtain wall (Tauchwand) and the plank bed (Vorpritsche) on the silting of the intake basin.*—The function of these parts is described and illustrated. The Tauchwand is a curtain wall on pillars which tends to keep the intake free from debris by a uniform distribution of velocities over the intake cross section. It also protects against ice and floating debris. The Vorpritsche is a smooth bed construction before the intake sill to keep the sill free from debris by extending the bottom outlet's field of influence farther upstream. In an intake at the outside of a river bend the Vorpritsche, because of its smoothness, does not weaken the spiral movement.

9. *Plan of the intake basin.*—Discusses the intake angle, and many illustrations show the effect of the angle in intakes from straight parts of the river and from bends. Flushing of intake basins is discussed.

10. *Bed-load movement over a weir and the bottom formation below a weir.*—Points out effects of stepped weirs during high water and low water insofar as retaining sediments on the steps of the weir is concerned. Many illustrations show the effects on sedimentation of opening the center or side bottom outlets. Prevention of scouring below weirs by Puchner-Hofbauer method is illustrated.

11. *Flushing of weirs and working channels.*—The functions of bottom outlets and sedimentation above weirs are described and illustrated, as well as the limited section above the weir which flushing may affect if the reservoir level is preserved. Flushing under different conditions is illustrated.

12. *Comparison of the measurements at the Peggau Dam on the Mur, with the results obtained from experiments with the model.*—These results are compared in detail with the aid of illustrations, and the author comes to the conclusion that the comparison resulted in the satisfying assurance that model experiments offer a reliable picture of bed-load movement and bottom formation at dams. Certain instances are pointed out where model experiments led to improvements in the flushing procedure at the Peggau weir.

357. Mayer, Robert, Über Erosion (On erosion): Geog. Gesell. Wien Mitt., Band 71, Nr. 10–12, pp. 299–330, 1928.

Written after visiting the Karlsruhe, Wien, and Graz hydraulic laboratories.

The new laws of water movement discovered by hydrotechnicians are explained in a general way by using as examples different types or sections of rivers, including wild mountain torrents, highland rivers, and lowland streams. Various forms of water movement, velocity distribution, waves, etc., are analyzed.

A section is devoted to each of the following items:

- Bed-load transportation.
- Equilibrium in cross section.
- High water.
- Equilibrium in longitudinal profile.
- Erosion base.
- Wave forms.
- Erosion and rock cliffs.

358. Reichel, Eberhard, Der Wasserhaushalt des Coloradogebietes im südwestlichen Nordamerika (Rainfall, run-off, and evaporation relations in the Colorado River Basin in the southwest of North America): Geog. Abh., 2. Reihe, Heft 4, pp. 1–74, Stuttgart, 1928. Also supplement: Leiter, M. M., Über die Denudation im Flussgebiete des Colorado.

The selection of the Colorado Basin for this study was suggested by A. Penck, because it contains arid sections.

The question to be answered is whether the run-off curve is actually a straight line.

The Penck formula $a=(n-L)\ k$ is used, in which a is run-off (Abfluss), n is precipitation (Niederschlag), L is an estimated precipitation at which there is no run-off, and k is a constant.

Reichel develops the following maps (scale 1:7,500,000):

1. Annual precipitation: 0 to 1,000 millimeters.
2. Gaging stations and silt-measuring stations.
3. Annual run-off: 0 to 400 millimeters.
4. Annual evaporation: 0 to 600 millimeters.
5. Run-off ratio: 0 to 60 percent.

To these Leiter adds:

6. Annual denudation: 0 to 0.5 millimeter.

Leiter's conclusions are:

1. Denudation is not the greatest in the higher districts with abundant rains, but in the arid districts.

2. Denudation is greater where sediments of Mesozoic age are on the surface than where early Paleozoic strata or eruptive masses appear.

Reichel indicates that the run-off is a function of the ground formation, besides being a function of climate—that is, temperature and precipitation.

General run-off curves are claimed to be straight lines bent in the middle, similar to the curve for the Colorado Basin.

In developing the denudation map Leiter has utilized the following references:

Geol. Survey Water-Supply Papers 274, 380, 395, 400, 469, 498, 538.
Geol. Survey Bulls. 350, 352, 730–C.
Geol. Survey Prof. Paper 93.
Penck, A., Morphologie der Erdoberfläche, Stuttgart, 1894.
Reclamation Service data on silt measurements.
Reclamation Record, May 1917.

Details pertaining to the Penck evaporation and run-off formula may be found in his paper entitled "Untersuchungen über Verdunstung und Abfluss": Geog. Abh., Band 5, Heft 5, pp. 463–504, Wien, 1896.

359. Amschler, J. W., Landwirtschaftliche Primitivkulturen des Kaukasus (Primitive agriculture in the Caucasus): Forschungen und Fortschritte, Band 5, pp. 147–148, 1929.

Brief notes covering an agricultural expedition.

Picture of terraces at Tschock Daghestan, 2,000 meters above sea level. Because of the total absence of trees in this district, dams and walls have been skillfully adjusted to the terrane in order to protect strips of land which are in places only 1 meter wide. Hook plows of local hardwoods (*Betula raddeana* and Tertiary birch) are used behind teams of 16 to 20 oxen to break up the clay soil into large lumps which, under the influence of the heat of the sun, gradually crumble.

362. Eriksson, J. V., Den kemiska denudationen i Sverige (Chemical denudation in Sweden): Statens meteorol.-hydrografiska anstalt Meddelanden, Band 5, No. 3, 96 pp., 1929.

Data on suspended matter and matter in solution obtained from observations made in 1909–25 at 69 stations. A total of 11,313 analyses were made, of which 3,594 were analyses for organic and inorganic matter.

Districts represented:

(*a*) Moraines rich in lime and clay soils with scant forest cover.
(*b*) Moraines rich in lime and clay soils with heavy forest cover.
(*c*) Clay plains with low lime content and having few forests and bogs.
(*d*) Forest districts relatively low in lime and with bogs.
(*e*) Mountainous districts, entirely or for the most part above the timber line.

Findings:

1. The content of inorganic matter in solution is in inverse proportion to the area of the drainage basin, to the volume of precipitation, and to the run-off factor.

2. In clay districts with few lakes the rivers contain much inorganic matter, but in forest districts with many lakes the rivers have a low content of inorganic matter.

3. The largest content of inorganic matter is in rivers that flow through regions rich in lime; the smallest content of inorganic matter is found in rivers that flow from mountainous regions.

4. Of the total quantity of inorganic substances found in the rivers, 35 to 40 percent is lime in districts such as *a* and *b*, and 10 to 30 percent is lime in forest and mountain districts such as *c*, *d*, and *e*.

5. The lime content in rivers increases with an increase in forest area as shown by the following table:

Forest area (square kilometers)	Average lime content (percent)
0–1,000	16
1,000–10,000	21.3
Above 10,000	24.8

6. The softest waters, partly under 1° (=10 milligrams CaO to 1 liter), come from forest districts and mountains; the slightly harder waters (4°–8°) are those that come into contact with lime under the ground surface; and the medium waters (8°–12°) are those that come from springs in limestone and Silurian formations.

7. The content of inorganic matter reaches a maximum during low water and a minimum during high water. The content of organic matter tends to be the opposite, in that the minimum usually occurs during the winter, and the maximum occurs during rising water in the spring.

8. The chloride content is the highest during the summer and fall.

9. The annual denudation in Sweden represented by the quantity of inorganic substances carried in solution by the rivers, in metric tons per square kilometer, for different parts of the country is as follows:

Lime districts	60–70
Forest districts	average 10, maximum 20
Mountain rivers	15–20

10. For the entire country of Sweden the estimated quantities carried in solution in metric tons per square kilometer per year are given in the following table:

	Inorganic	Organic	CaO	Cl	SO_3	CO_2
Moraine districts	11.3	7.8	2.8	5.6	0.9	3.0
Clay districts	15.0	10.7	3.3	3.1	2.3	2.6
Lime districts	19.4	19.4	6.9	2.1	3.2	4.3

11. The average total per annum denudation by rivers in Sweden is as follows:

	Metric tons
Inorganic matter	6, 140, 000
Organic matter	3, 930, 000
CaO	1, 570, 000
Cl	930, 000
SO_3	680, 000
CO_2	1, 430, 000

12. Of the total chemical and mechanical denudation, 70 to 90 percent is chemical.

This abstract is based on a German review by R. Mayer.

367. Rehbock, Theodor, Bettbildung, Abfluss und Geschiebebewegung bei Wasserläufen (Formation of river bed, run-off, and bed-load transportation by rivers): Deutsche geol. Gesell. Zeitschr., Band 81, Heft 10, pp. 497–534, 1929.

Lecture given at a meeting of the Deutsche geologische Gesellschaft (German Geologic Association) in Karlsruhe. Points out that the subject enters the field of the geologist, the geographer, and, most of all, the hydraulic engineer.

A typical river of central Europe is analyzed from the mountain torrent to the delta. All important geologic, hydrologic, and especially hydraulic features are mentioned and definitions given. Attention is called to features still requiring research, and the assistance of the geologist is invited in solving the problems. The great assistance rendered by laboratories is pointed out.

370. Düll, Ferdinand, Das Gesetz des Geschiebeabriebes (The law of bed-load attrition): Mitt. aus dem Gebiete des Wasserbaues und der Baugrundforschung, Heft 1, 62 pp., Berlin, Wilhelm Ernst & Sohn, 1930.

After reviewing former contributions toward the solution of the problem and analyzing numerous experiments, the author comes to the conclusion that former attrition formulas are not suitable and therefore he develops the following formula:

$$G=[G_o^{1-n}-(1-n)ks]^{\frac{1}{1-n}}$$

in which G is the weight of a stone at the end of a given distance of travel.
G_o is the initial weight of a stone.
s is the distance traveled.
k is a factor representing the relative attrition hardness of the material.
n is a factor representing the relative brittleness of the material.

For normal attrition where the surface of the stone remains smooth without large particles breaking off, $n=0.55$, so that

$$G=(G_o^{0.45}-0.45\ ks)^{\frac{1}{0.45}}$$

For distances through which the final weight G does not greatly differ from G_o the following approximate formula may be used:

$$G=G_o-ks\ G_o^{0.55}$$

For different kinds of rock, as well as for individual stones of the same kind of rock, k and n are found to be variable, so that only observations based on averages are of practical use. Compared to these unavoidable variations the influence of the river's slope and of the form of the rounded bed-load stones becomes insignificant and may be ignored.

The type of bed-load material (sharp-cornered or round, rough or smooth) surrounding the individual stone is of critical importance.

Although the experiments do not prove that the quantity (mass) of the bed load influences the result, it is quite probable.

The experiments described have not solved the problem of attrition but merely clarified certain points.

To arrive at a solution laboratory experiments should be combined with critical observation of natural attrition.

The paper contains many illustrations, diagrams, tables, and a bibliography of 21 entries, dated from 1857 to 1926.

372. Freise, F. W., Boebachtungen über den Schweb einiger Flüsse des brasiliànischen Staates Rio de Janeiro (Observations on suspended matter in certain rivers in the State of Rio de Janeiro, Brazil): Zeitschr. Geomorphologie, Band 5, Heft 5, pp. 242–244, Leipzig, 1930.

The observations are based on over 20 years' experience in the field. The data cover a variety of areas from those with practically no soil to those having virgin forests with a soil depth as great as 5 meters. Data for 19 rivers are given.

The results indicate that the percentage of fine particles increases with the percentage of virgin forest. In the virgin-forest district the Mambucaba River carries off yearly about 18 grams per square meter of drainage basin, of which about 83.55 percent represents particles less than 0.002 millimeter in diameter. Flowing through a district which has been settled for 175 years, the Muriahe River carries off about 59.3 grams per square meter, of which only about 22.47 percent consists of particles less than 0.002 millimeter in diameter.

374. International Congress of Soil Science, 2d, July 20–31, 1930, Leningrad and Moscow, Proceedings and papers published in Moscow, 1932–33.

These papers are published partly in English, partly in German and consist of the following volumes, which are designated commissions:

Commission 1. Soil physics. 304 pp. Contains 26 papers on capillarity, mechanical analysis, colorings, structure, physical properties, soil moisture, etc.

Commission 2. Soil chemistry. 226 pp. Contains 31 papers on pH of soil, absorption, colloids, lime, phosphates, organic matter, etc.

Commission 3. Nitrogen fixation, decomposition of organic matters, and soil microbiology. 301 pp. Contains 55 papers.

Commission 4. Soil fertility. 262 pp. Contains 34 papers on methods of determining soil fertility, soil reaction on yield of plants, soil acidity, plant nutrition, soil map of the world, etc.

Commission 5. Classification, geography, and cartography of soils. 424 pp. Contains 71 papers on origin of soils, morphology, forest soils, alkali, soil maps, etc.

Commission 6. Application of soil science to agricultural technology. 320 pp. Contains 30 papers on drainage, permeability, absorption, underground waters, irrigation, reclamation, freezing, erosion, peat soils, etc.

Commission 7. Proceedings and excursion. 159 pp. Contains miscellaneous papers and list of 39 publications edited for the second congress.

382. Stebutt, A., Lehrbuch der allgemeinen Bodenkunde; der Boden als dynamisches System (Textbook of general soil science; the soil as a dynamic system), 518 pp., Berlin, 1930.

Stebutt considers soil as a living, organic body. The constant energy influx from without either maintains a balanced state or produces further development.

The contents include treatment of the following subjects:

1. Raw soil-forming materials; soil as a colloidal system; the physical properties of soil; porosity; behavior toward water, air, organic matter, and heat.
2. Soil dynamics; the factors of the soil processes; reaction of water, carbon dioxide, and humus; changes of the materials; decomposition of minerals and building up of the soil components; soil acidity; change and displacement of the whole soil; alluvial and diluvial processes.
3. Soil genetics; typical soil formations.
4. Theory of soil fertility.

383. Stremme, Hermann, Wissenschaftlicher und wirtschaftlicher Wert der Bodenkartierung (Scientific and economic value of soil cartography): Forschungen und Fortschritte, Band 6, p. 39, 1930.

Extracts from a lecture in which it is claimed that former general and special maps were inadequate because soil science had not been developed sufficiently at the time. Modern soil cartography considers types of soil origin as one of the main bases.

From the sciencific viewpoint soil maps give exact statistics. From the economic viewpoint soil maps may give information in regard to soil values in agricultural and forestry practice in view of their relations to the science of vegetation. Another article by this author is contained in Forschungen und Fortschritte, Band 8, p. 46, 1932.

385. Zólcinski, J., Deluviale Bodenprozesse als heimliche Plage der Landwirtschaft; Bodenab- und Aufschwemmungen als Folge des mechanischen Ackerbaues und der atmosphärischen Niederschläge (Deluvial soil processes as a secret plague of agriculture; soil erosion and sedimentation as results of mechanical soil cultivation and atmospheric precipitation): 2d Internat. Cong. Soil Sci., 1930, Proc. and Papers, Comm. 6, pp. 203–207, Moscow, 1932.

Deluvial processes are defined as the erosion and transportation of weathered rock and soil materials from cliffs and slopes of the macro- or microrelief into depressions of all kinds below the level of such a relief. These processes may be caused by the flow of rain or snow water or by works of man such as mechanical soil cultivation.

It has been established that deluvial processes of soil erosion and sedimentation are more or less continuous, although varying in intensity, and are in direct relation to the different mechanical characteristics of the soils as well as to the amount of precipitation. The potentialities for erosion increase with a decrease in binding materials, such as humus and clay, or with an increase in fine dusty sand.

The dust soils, which are composed of fine particles, possess, in regard to their mechanical and morphologic character, a weaker, less permanent, and characteristic field structure, and under the destructive influences of precipitation and mechanical soil cultivation they undergo a far-reaching deluvial soil transportation into depressions and valleys.

These denudations depend upon abundance of folds, the slope angle, and the slope direction. As a rule deluvial processes on the northerly slopes show moderate progress, but toward the south and especially the southeast they have progressed much farther.

Normally lying gray steppe-forest soils with a slight slope (4 to 6 percent) will under cultivation and weathering erode so that the dark humus layer is transported to the foot of the slope, followed first by the light-gray layer of the podzol horizon and later by the iron-yellow layer. At a considerable slope (10 to 16 percent) the normally lying genetic gray steppe-forest soils appear in the reverse order after deluvial erosion.

In soil erosion a considerable loss of plant-nourishing elements (nitrogen, phosphorus, and potassium) takes place. These collect along the slopes leading to the depressions.

Thorough investigations of deluvial sedimentation show that—

(*a*) In sedimentation often two layers appear, consisting of an ash-gray dusty sand and a dark humus layer.

(*b*) The sedimentary material first fills the depressions in the terrane and then is separated into layers.

(*c*) The processes of erosion and sedimentation take place much quicker and more intensively than has been assumed. For example, on a slight slope of 5 percent in a valley during a period of 7 months 5.5 to 6 centimeters of eroded material was deposited.

386. Blanck, E., Handbuch der Bodenlehre; die Massnahmen zur Kultivierung des Bodens (Handbook of soil science; measures applied for the cultivation of soil), 583 pp., Band 9, Berlin, Julius Springer, 1931.

Of special interest in this volume is Graf zu Leiningen-Westerburg's treatise on forestry, fertilization, and the influence of forest vegetation on soil. The dependence of the formation of the soil profile on the vegetation is shown, and it is demonstrated that even radical changes in the profile require often only a surprisingly brief time.

Another chapter in this volume is by Mitscherlich and is entitled "The soil as a vegetation factor."

This book is one of a set of 10 volumes.

387. Congrès international de navigation, Le service hydrographique italien (Italian hydrographic service), 416 pp., 15e Cong. internat. de navigation, Venise, Rome, 1931.

This report is largely on hydrology but also includes meteorologic data.

Few sections of Italy have less than 400 millimeters of annual precipitation, and the amount increases to more than 3,000 millimeters in the Friaul regions.

The results of discharge conditions in the Italian rivers are well covered, as, for example, the River Po, for which glacier action, changes in river bed, delta formation, and artificial irrigation near the source are described.

In 1930 the artificial lakes of Italy contained 1,500,000,000 cubic meters, as against 8,000,000 cubic meters in 1910. The artificial lakes in 1930 were distributed as follows: Northern Italy, 90; central Italy, 34; southern Italy, 16; total, 140. Most of these artificial lakes are used for water power.

Hydrologic terms as applied in Italy are defined.

This volume also contains the French translation of Giandotti's paper entitled "A contribution to the study of the transportation of (solid) matters on river beds." This paper originally appeared in Annali dei lavori pubblici, Rome, 1929. The following paragraphs are an abstract of the paper.

The author considers that the solution of the problem of the transportation of bed load by water is one of the most difficult tasks, because it has to be based partly on laboratory experiments, where all the natural conditions cannot be properly simulated, and partly on field observations. The results of such observations, however, cannot be fully utilized without taking into consideration the particular geologic, cultural, morphologic, climatic, and hydraulic river conditions under which the observations were made.

Credit is given to the contributions of Möller, Faber, Schoklitsch, Schaffernak, and Lüders. The author does not intend to propose a new system of research but merely submits the results of simple statistics, which, however, are sufficient to give an idea as to the quantity of bed load which may be transported by the rivers descending from the North and Central Apennines and by the tributaries of the Po River from Scrivia to Danaro. On the basis of the geologic data of Prof. Sacco, the rock formations of the last-mentioned district are analyzed as to their degree of resistance to erosion. The characteristics of the river channels are analyzed in order to obtain typical section profiles, etc.

The following data are given for 19 rivers:

1. Area of drainage basin.
2. Average altitude above sea level.
3. Average slope.
4. Average annual precipitation, 1923–27.
5. Average maximum precipitation for 4 consecutive days.
6. Quantity of bed load transported annually.
7. Annual denudation of basin, in cubic meters per square kilometer.

Sternberg's figures on attrition as applied to the Rhine between Basel and Mannheim are given.

The final conclusions are that eight of these rivers carry annually 100 to 120 cubic meters of sedimentary material per square kilometer of drainage basin, five rivers carry 50 to 60 cubic meters per square kilometer, and six carry 30 to 40 cubic meters.

396. Jakuschoff, Paul, Die Schwebestoffbewegung in Flüssen in Theorie und Praxis (Movement of suspended matter in rivers in theory and practice): Inst. Wasserbau tech. Hochschule Berlin Mitt., Nr. 10, 24 pp., 1932; reprint from Wasserwirtschaft, 25. Jahrg., Hefte 5, 6, 7, 8, 11, Wien, 1932.

This paper is an attempt to gather the scant and partly contradictory data on the movement of suspended matter, in order to make a résumé and to indicate directions for further research.

The principal problem is to investigate how suspended matter is transported for considerable distances in flowing water without touching the bed. The movement of water itself is also not yet fully understood.

The history of the development of this problem is briefly given, beginning with the work of E. Dupuit in 1786 and ending with the present theory that an understanding of turbulence will lead to an explanation of the transportation of suspended matter.

After this introduction a chapter is devoted to each of the following items:

1. *Importance of and determination of the composition of suspended matter.*—Formulas covering velocities of particles falling in water, air, etc., are given. Methods of mechanical analysis are discussed only in general. Special mention is made of Glushkoff's method, in which the particles fall through a long tube onto a moving tape so arranged that the time required for passing through the tube is automatically registered and the particles are automatically grouped.

For particles larger than 0.5 millimeter the sieve method is recommended.

2. *The essence of turbulence.*—O. Reynolds' critical number for the limit between laminar and turbulent flow and Schoklitsch's turbulence experiments with coloring matter are briefly reviewed. The opinion is expressed that in spite of the attempts of numerous research workers during the last 2 or 3 decades the largest part of the turbulence problem is still unsolved, and that neither the origin of turbulence nor the law of cross movements has been explained, nor has any mathematical theory been developed that is even approximately correct.

Attention is called to numerous other differences between laminar and turbulent flows besides those expressed by the Reynolds' number.

3. *Ways for calculative treatment of suspended-matter movement.*—It is suggested that this can be done through relations derived from experiments, or by formulas for cross components of flow velocity. Numerous experiments by J. B. Francis, W. Glushkoff, M. Welikanoff, and H. Krey and numerous formulas by R. G. Kennedy, N. Joukowsky, J. V. Boussinesq, Jasmund, W. Schmidt, L. Prandtl, and W. Tollmien are reviewed, and additional research pertaining to the principle of the Austausch processes is recommended.

4. *Mathematical analysis of the movement of suspended matter on the basis of its composition.*—Attention is called to the Russian contributions along this line, principally by W. Glushkoff. This subject is treated with considerable detail.

5. *Connection between suspended movement and the carrying capacity of rivers.*—Discusses the shift from erosion (scouring) to sedimentation (silting) and vice versa.

6. *Distribution of suspended matter in rivers.*—(*a*) Over cross section; (*b*) along the length of the river.

7. *The volume of suspended matter carried by rivers and the resulting effects.*—Attention is called to the large fluctations in the ratio between bed load and suspended matter as observed in different rivers by various investigators.

The relation between velocity of flow and turbidity and between turbidity and run-off is discussed. The influence of suspended matter on the movement of water in the river is considered.

8. *Apparatus required for determining the content of suspended matter and its proper use.*—Description and illustrations of apparatus are given. Preference is given to Glushkoff's collapsible dipper for silt sampling.

9. *Photoelectric method for determining the suspended matter content of rivers.*—Kalitin's apparatus is described and illustrated.

10. *Comparison of movement of suspended matter in water and in air.*—The author maintains that the same laws are applicable to both air and water.

Conclusion.—The question of movement of suspended matter is very closely related to the run-off processes and to the turbulence problem, which is the chief problem and must be solved first, because without that all our hydraulics represent only a collection of merely empirical formulas not connected by any strict system.

A bibliography of about 85 entries is given.

400. Dietz, Curt, Künstliche Sandverkieselung (Artificial silicification of sand): Zeitschr. prakt. Geologie, Jahrg. 41, pp. 57–61, 1933.

The process consists in treating sand first with a concentrated solution of silicate of soda and then with a salt solution, usually calcium chloride. The treatment causes a flocculation of silica gel and a quick hardening of the sand. Both solutions are applied under pressure by Dr. Joosten's method.

It has had practical application in connection with mining, preparation of footings and foundations, etc.

This article considers the process from the geologic viewpoint and finds it to be an imitation of natural sandstone formation.

403. Favre, Henry, Contribution à l'étude des courants liquides (A contribution to the study of flowing liquids), 64 pp., Zurich, 1933.

This book is intended for engineers who are not interested in the scientific details but who want a practical and quick solution of questions pertaining to the behavior of the liquid mass as a whole.

In addition to the classical hydraulic values relating to roughness and velocity, the author considers in his calculations also nonuniform distribution of velocity in the cross section, as well as changes produced by an increase or reduction in the discharge. The results given have been checked in the field and in the laboratory, and the arrangement is considered convenient for the practical engineer who is interested in discharge phenomena.

404. Flohr, E. F., Beitrag zur Methode der kartographischen Darstellung von Wasserkräften, unter vorwiegend morphologischen Gesichtspunkten (Contribution to the method of cartographic representation of water powers, chiefly from the morphologic point of view): Schlesische Gesell. Erdkunde und Geog. Inst. Univ. Breslau Veröffentl., Heft 20, 82 pp., 1933.

Water power is here to be understood as the maximum power available from precipitation for mechanical-morphologic work. It represents the upper limit of effective water power, which is the upper limit of the usable water power—that is, the potential water power of the technician.

In the introduction, A. Penck's map of potential water powers in the United States is discussed as a starting point. After that, the drainage basins of the Wilde and Rote Weisseritz are treated thoroughly, with descriptions of the topography, geologic structure, forests, precipitation, and run-off. The utilization of data in the construction and interpretation of the map is explained.

The basic formula for the construction of such a map is

$$K=(m)\ (g)\ (J)$$

in which K=annual potential power at a given location.

m=mass of the annual run-off.

g=acceleration due to gravity.

mg=weight of annual run-off.

J=slope=h/s, in which h is the difference in altitude and s is the distance traveled.

The author explains that if the kinetic energy formula $K=(m)\ (g)\ (h)$ were used K would be expressed in meter kg/year, but in the new formula $K=(m)\ (g)$

(J), instead of h, à concrete figure in meters, there has been substituted J, which is a ratio, so that K is then expressed in kg/year.

The ultimate map, with a scale of 1:100,000, indicates sections that range from 0 to 466,000,000 kg/year.

The Weisseritz drainage basin was selected because all necessary data pertaining to it were available.

In making hydrodynamic maps, which are intended principally to serve morphologic purposes, it is desirable that:

1. The determination of the water power be made at the local erosion base-levels—that is, at places where the slope or the area of the drainage district are changing.
2. Besides the average annual discharge, the average discharge of the high-water period should be considered.
3. Occasionally the relations in other time units, such as seasons or months, and in special occurrences, such as catastrophic high water and extreme low water, should be mapped.
4. The scale should vary according to the requirements and the quality of the hydrologic data.
5. Surface representation of water power, similar to A. Penck's isohydrodynames, is not recommended.

The paper contains a bibliography of 100 entries.

405. Gontscharoff, W. N., O vzvieshivaniĭ nanosov (On the suspension of sediments): Gidroenergeticheskiĭ nauchno-issledovatel'skiĭ inst. Trudy (Hydro-energy Sci. Research Inst. Trans.), vypusk 2, 174 pp., Moscow, 1933. Reviewed in Wasserkraft und Wasserwirtschaft, 30. Jahrg., 24. Heft, pp. 291–292, 1935.

About one-half of the paper is devoted to the general problems of turbulent flow. After analyzing some formulas for determining the average velocity, such as those of Mises and Fromm, the author develops his own formula, in which the velocity is represented as dependent upon the degree of smoothness (not roughness) of the channel. The value of this coefficient is then computed for various hydraulic conditions.

A critical review of modern conceptions of the effect of the boundary surface and wall friction is given. This is followed by a treatment of the author's theories on the mechanics of turbulent flow.

The subject of suspended matter is treated, and the Airy formula is criticised.

A complete picture of the distribution of suspended matter and bed load in rivers and canals is given and various conceptions as to the nature and laws of the transportation of suspended matter are analyzed.

In conclusion, the author gives a synopsis of numerous formulas, mostly empirical, which are used for practical calculations in connection with canal improvements, from Kennedy's formula (1894) to Bakhmeteff's formula (1929). The author criticises all of them because they do not agree with observed data and are based on faulty construction.

This abstract is based on a German review in Wasserkraft und Wasserwirtschaft 30. Jahrg., 24. Heft., pages 291–292, 1935.

407. Lugeon, Maurice, Barrages et géologie; méthodes et recherches, terrassement et imperméabilisation (Barrages and geology; methods and research, terracing and impermeabilization), 138 pp., Lausanne, F. Rouge & Co., 1935.

Most of the book deals with geologic studies of dam sites and the proper preparation of dam foundations. There is one chapter on silt deposits in reservoirs. Contains 15 drawings and 63 photographs.

414. Becker, Anton, Die geographische Wertung der Wüstungen (Geographic appraisal of abandoned lands): Geog. Gesell. Wien Mitt., Band 77, Nr. 7–9, pp. 146–181, 1934.

Considerable space is given to a discussion of terms pertaining to abandoned land which is accompanied by a footnote bibliography covering not only authors and their articles but numerous lengthy quotations from the original documents.

The causes to which various authors have attributed the abandonment of lands and villages in Austria are floods, mountain slides, the call of the city, wars, pestilences, forced transmigrations, emigrations, sedimentation by rivers, raising of river beds, changes in the level of underground water, climate, dust storms, erosion, burning of forests to provide more pastures, and exhausted soil. Finally the author comes to the conclusion that the geographic position of a settlement is the real cause of its abandonment.

419. Keller, A. J., Wasserführung, Sinkstofführung und Schlammablagerung des alten Rheins (Discharge, suspended matter, and silting in the old Rhine): Schweizer. Bauzeitung, Band 104, Nr. 6, pp. 63–64, 1934.

This article is an extract from a book of the same title published in 1932 as Mitt. Nr. 31 des Eidg. Amtes für Wasserwirtschaft in Bern.

The experiments on scouring were made with two kinds of silt:

Sample	Percent of grain sizes	
	0.1 to 2 mm	Under 0.1 mm
1a	55	45
1b	20	80

The behavior of these two silts was basically different, as shown by the following table, which indicates the velocities at which scouring took place in different depths of water:

Sample	Depth of water (meters)	Scouring velocity (meters per second)
1a	0.4 to 1.0	0.55
1b	.40	.90
1b	.70	1.05
1b	1.00	1.15

It will be noted that approximately twice as great a velocity was required to scour the finer silt (*b*) than to scour the coarser silt (*a*). The latter may be considered sand; the former is grouped as a clay (loam), the smooth surface of which is not as effectively attacked by water.

The increase in resistance to scour with an increase in depth of water may be attributed to the fact that with a higher water pressure the cohesion of the silt particles increases.

For the settling experiments silt 2 was used, which was representative of 15 samples taken at 300-meter intervals in the Old Rhine. The composition of the sample was as follows:

Grain size (millimeter)	Percent of total
0.1 to 1.0	15
Under 0.1	85

Silt 2 behaved as follows:

Grain diameter (millimeter)	Suspension velocity limit (meters per second)
0.01	0.30
.05	.50
.1	.65
1.0	About 1.30

At lower velocities the respective grain sizes settled at the following speeds:

Grain diameter (millimeter)	Settling velocity (meters per second)
0.01	0.157
.05	.525
.10	1.620

From additional experiments it was established that the grains of larger diameters continue to roll along the bottom as bed load after settling, and that the finer particles are transported apparently only in a suspended state.

The roughness coefficients, as given by Strickler and Chezy, are analyzed on the basis of the experiments made.

These experiments were conducted for the purpose of deciding whether it would be safe to regulate the Old Rhine for a channel width of 25 meters as requested by the navigation interests, instead of 16.5 meters, as intended by the Government.

The calculations showed that by widening the channel to 25 meters no silt would accumulate. On the contrary, a certain amount of scouring might take place.

420. Köbler, K., Über die Notwendigkeit eines Bodenschutzgesetzes (On the necessity of a law for soil protection): Wasserkraft und Wasserwirtschaft, 29. Jahrg., 22. Heft, pp. 263–266, 1934.

Previous articles on soil protection by this author are referred to. Systematic government regulation is considered essential on all types of earthworks, dams, canals, sluices, and wells. It is maintained that the smaller items are especially neglected. Proper maintenance of costly public works is also believed essential.

The time has come to take the same steps in regard to water resources as were taken half a century ago in regard to roads. The following tentative scheme is drawn up and entitled "Law for the conservation, amelioration, and reclamation of soil suitable for agriculture."

1. The aim of this law is to protect the soil used or suitable for agriculture or gardening. Furthermore, it has to provide for planned supervision of the soil, to create the necessary foundations for planned amelioration and reclamation, and to assure food supplies for the German people in their own country.

2. Temporary or permanent occupation of soil for structures, works, etc., of every description or for other purposes requires a permit in accordance with this law, regardless of permits that may be required by other decrees or laws. Similarly a change in the present type of structures and developed areas of existing establishments requires a permit for further works, establishments, etc., which may limit or endanger the natural use of the soil.

3. Excepted from such permit requirement of this law are the country settlements, as well as soil cultivation work and connected measures, to the extent to which they are being planned or executed by the Reich or the provinces.

4. The permit is to be denied or is to be conditional if the intended measures cause a temporary or permanent impairment of the food supply for the German people which is greater than the anticipated advantage of a private or national economic nature.

5. Each owner of soil utilized for agriculture is obliged to keep the soil in a condition of cultivation which, in accordance with location, climate, soil composition, and underground conditions, assures the best possible yield.

Ornamental gardens, parks, cemeteries, natural reservations, etc., already in existence at the time this law takes effect are not interfered with, but an express authorization, with a view of subjecting them to this law, is required for all other free grounds, as play and sport grounds, small garden lands, etc.

6. Whosoever neglects land of the kind described in the first part of paragraph 5 or fails to improve other soil which in accordance with corresponding measures is to be made useful may, after a set date, be declared obliged to cede his soil in entirety or in part, permanently or temporarily, at a price based on the existing yield value.

7. The decrees of paragraphs 5 and 6 may also be applied to owners of moors, waste lands, and water areas of every kind.

8. The issuing of the permit and the defining of duties is to come under the jurisdiction of the Reich's food minister. He may transfer his authority entirely or for certain cases to the central authority of the province.

After that, the author shows the justification for such a law by pointing out that

1. The soil, the German people's most valuable asset, is still practically unprotected and subject to any kind of wastefulness and destruction.

2. At present the owner of the soil acquires an almost complete right of control and may do as he pleases.

3. The soil itself, except where used for forestry purposes, has no protection at all, except in some special cases.

4. Forestry, in general, is based on better laws.

5. It is an intolerable condition to spend large public sums for amelioration of soils, while there exists no law against wasting soil.

6. All construction permits are controlled by regulations for protection of the public interest, but the soil on which all construction takes place is left without any protection.

7. The new law would prevent land speculation.

422. Meinardus, W., Eine neue Niederschlagskarte der Erde (A new precipitation map of the earth): Petermanns Mitt., Jahrg. 80, pp. 1–4, 141–143, 1934.

This map may be summarized as follows:

	Centimeters
Average annual precipitation on the earth as a whole	100
Average annual precipitation on land	67
Average annual precipitation on sea	114
Average annual precipitation on land of Northern Hemisphere	63
Average annual precipitation on sea of Northern Hemisphere	124
Average annual precipitation on land of Southern Hemisphere	76
Average annual precipitation on sea of Southern Hemisphere	106
Average for zone of heaviest precipitation between 0° and 10° latitude	186
Average for zone between 20° and 30° latitude	80–90
Average for polar districts above 70° latitude	Less than 20

Within each zone there are essential differences depending upon the varying distribution of land and sea, soil relief, and, especially in the coast districts, air and sea currents.

The subtropical zones are not necessarily low in precipitation, but, on the contrary, have abundant precipitation on the easterly sides of the continents, as in China, Japan, Atlantic States of the United States, southern Brazil, central Argentina, Natal, and eastern Australia.

The temperate zone has little precipitation over the broad plains of the northern continents but has abundant precipitation on the western coasts, as in Norway, the British Isles, Alaska, Colombia, and western Patagonia.

Considering the earth as a whole, the annual precipitation should approximately equal the annual evaporation. The latter would average about 100 centimeters over the earth's surface and in total volume would be 511,000 cubic kilometers of water. The latter figure is one-third greater than the quantity which up to now had been estimated on the basis of measurements and held to be theoretically possible.

The evaporation from the sea is now calculated to average 124 centimeters and that from the land 42 centimeters, after considering the total volume of run-off from the land to the sea to be 37,100 cubic kilometers. The evaporation from the sea is calculated to total in volume 449,000 cubic kilometers, or more than seven times greater than the evaporation from the land, which has been calculated to be 62,000 cubic kilometers.

These results vary considerably from G. Wuest's findings, in which the evaporation from the land was 50 centimeters and that from the sea 84 centimeters. After taking into consideration the areas of the land and the sea, the evaporation on sea was only about four times more than the evaporation from the land according to these calculations.

This abstract is based on the author's article entitled "Die jährliche Niederschlagsmenge der Erde": Forschungen und Fortschritte, Band 10, page 156, 1934.

423. Meinardus, W., Die Niederschlagsverteilung auf der Erde (Distribution of precipitation on the earth): Meteorol. Zeitschr., Band 51, Heft 9, pp. 345–350, 1934.

The paper contains tables of average annual precipitation in 5°, 10°, and 20° latitudinal zones and summaries for the hemispheres, the whole earth, the land, and the sea.

Evaporation and the hydrologic cycle are discussed in detail. It is estimated that the vapors of the atmosphere renew themselves at least 41 times during the year and return to the earth after a maximum of 9 days.

424. Oppokow, Eugen, Abfluss und Verdunstung als Funktion des Niederschlags im Flussgebiete (Run-off and evaporation as a function of the precipitation on a river basin): Wasserkraft und Wasserwirtschaft, 29. Jahrg., 5. Heft, pp. 55–57; 6. Heft, pp. 67–70; 7. Heft, pp. 78–83, 1934.

After a brief review of the contributions of other hydrologists to the problem of the relations of precipitation, run-off, and evaporation, the author analyzes the data on several rivers, using annual values represented by the following symbols:

y=calculated uncorrected run-off.
x=precipitation.
$\pm t$=water consumption or storage value for individual years.
u=corrected river run-off for individual years.
z=actual evaporation.

All quantities are expressed in millimeters.

The important features are:

1. To produce a straight relation between run-off and precipitation, the calculated run-off y is corrected to the value u by the term $\pm t$, which is the consumption in dry years or the storage of water in the drainage basin in years of more abundant rains.

2. The result is the Penck-Oppokow formula $x-z=y\pm t=u$, which is applicable not only to the averages for a number of years, but also to single years.

3. The evaporation, which is represented by the equation $z=x-y\pm t$, is dependent on the precipitation. Penck's conclusion that river run-off is dependent on the precipitation in the river basin is also true of the evaporation.

4. Assuming the equations

(1) Penck's for upper Elbe ---------- $y=0.55\ (x-355)$
(2) Oppokow's for upper Dniepr ---------- $y=0.83\ (x-395)$
(3) Oppokow's for upper Weser ---------- $y=0.617\ (x-285)$

and observing that each of these equations at the same time represents the function u of the corrected run-off, we may calculate the corrected run-off for each year from the respective precipitation.

The results for the corrected run-off u produced a straight line when plotted against the precipitation for corresponding years.

5. As y in section 4 represents the corrected run-off, u may be substituted for it in section 3, giving the following equations for the evaporation:

(4) Upper Elbe ---------- $z=x-y=0.45x+195$
(5) Upper Dniepr ---------- $z=x-y=0.17x+328$
(6) Upper Weser ---------- $z=x-y=0.383x+176$

from which the corrected value of the evaporation for individual years may be computed.

6. The author also gives the following equations for the average annual run-off:

(7) Upper Elbe (based on Penck's data) ---------- $y=0.476\ (x-290)$
(8) Upper Saale (based on W. Ule's data) ---------- $y=0.554\ (x-314)$
(9) River Theiss above Szegedin (based on P. Vujevic's data) ---------- $y=0.635\ (x-402)$
(10) River Dal-Elf (based on A. Wallens' data) ---------- $y=0.952\ (x-140)$

Corresponding to these run-off equations the evaporation equations are obtained:

(11) Upper Elbe ---------- $z=0.524x+138$
(12) Upper Saale ---------- $z=0.446x+174$
(13) River Theiss ---------- $z=0.365x+255$
(14) River Dal-Elf ---------- $z=0.048x+133$

E. Reichel gives for the Colorado River analogous equations of run-off but with much wider fluctuations in the coefficients, varying from 0.05 to 0.93. However, he uses an entirely different method of calculation. The very low coefficient 0.05 applies to subtropical districts with annual temperature of 18° C. and over; the coefficient 0.93 to districts of average annual temperature of 3° C. and less, which correspond in climate and run-off to those of Sweden.

7. To find on the basis of the corrected run-off u the actual value y for each individual year, it would be necessary to find the value $\pm t$ in the district for each year. In districts where the precipitation data for past years are available, but data for run-off y are not available, the latter could be easily calculated if the values for equations such as (1) to (3) and (7) to (10) are known.

8. Further investigations of long-time records of precipitation and run-off in different river basins are considered important.

The rather scant data quoted by the author form a basis for the assumption that the river run-off changes with the precipitation in different years somewhat less, but that the evaporation changes somewhat more, than is assumed by K. Fisher and H. Keller. Their assumption fits more nearly the hydrologic and climatic conditions of Sweden, but for central and western Europe there apparently exist different relations between run-off and evaporation on one hand and precipitation on the other hand, which differ markedly from the Fischer-Keller assumption but are close to A. Penck's data for 1896.

427. Schottenloher, Rudlof, Die Gebirgsumrahmung des nordamerikanischen Kontinents (The mountain border of the North American continent): Geog. Gesell. Wien Mitt., Band 77, Nr. 7–9, pp. 129–145, 1934.

The paper is an attempt to view the North American continent as a unit of "centripetal" nature as compared to "centrifugal" Eurasia.

The system of tectonic lines, the geosynclinal location of the mountains, the orogeny or mountain formation, the domes of the central country, and the morphology of the mountainous areas of today are discussed with considerable detail.

The author considers the great central plain as the main treasure chamber of North America, and so regards this continent as "centripetal-unitaristic" in character.

A bibliography of 38 entries is given.

431. Dienert, F., Des moyens d'etude du cycle de l'eau dans la nature (Means for the study of the natural hydrologic cycle): Rev. gén. hydraulique, no. 2, p. 77, 1935.

The paper begins with a discussion of the presence of water vapor in the atmosphere and water in the soil. Condensation in the atmosphere and as dew is analyzed. The two theories of dew, (1) that dew is formed from the vapors rising from the soil and (2) that dew is a condensation of atmospheric vapors, are discussed.

The methods for measuring evaporation directly, as well as for calculating it on the basis of a constant difference between precipitation and run-off, are reviewed. Attention is called to the difficulties in connection with measuring infiltration. It is proposed to set up an elaborate system of underground measurements, consisting of a dense network of stations, so that all different topographic features including swamps, forests, cultivated fields, ground below river bed, different depths of soil, etc., are covered. By comparing such measurements with the results of other methods, the flow from thermal springs may be determined. That part of the water which returns from the soil in a state of vapor is determined by the author's apparatus for measuring ground evaporation. Thus it is found possible to observe the various phases of the natural hydrologic cycle in different regions, to study the influence of topographic and meteorologic conditions, and to obtain data pertaining to the penetration of precipitation at different depths.

This review is based on a German abstract in Wasserkraft und Wasserwirtschaft, Band 31, pp. 10–11, 1935.

432. Fels, E., Der Mensch als Gestalter der Erde (Man as shaper of the earth), 206 pp., Leipzig, Bibliographisches Institute, 1935. Bibliography.

The following subjects are treated in a nontechnical style:

1. Man as shaper of climate.
2. Reshaping of the earth's surface by settlements, mining, agriculture, changes of coast, and deforestation.
3. Changes in underground water levels.
4. Drainage.
5. Regulation of rivers and lakes.
6. Irrigation.
7. Vegetation.
8. Animal kingdom.
9. Transportation.

These subjects are treated from the standpoint of man's direct and indirect effect on the earth, and the resulting reaction on man.

Pages 50, 51, 56–58 are devoted to results of soil cultivation and deforestation.

The most far-reaching results are attributed to afforestation and deforestation.

A very definite role is attributed to terracing, which at different periods has been practiced on varying scales by almost all nations on the earth and in all climatic zones. Besides preventing erosion, terraces also facilitate artificial irrigation. The European Mediterranean districts are mentioned as the best-known examples of regions where terracing has reached a highly developed state through generations of labor. These terraces have to be constantly cared for. Any cloudburst may have devasting effects. Any negligence is bound to have disastrous consequences. It is very characteristic how quickly in politically disturbed times terrace cultures may be ruined. Greece under the Turkish domination of several centuries is a notable example.

Soil cultivation by plowing tends slowly but steadily to level the surface and gradually lower the cultivated lands.

The composition of soils is also changed through cultivation.

Regressive cultivation methods make soils poorer while advanced and scientifically justified methods improve the soil. Artificial irrigation also may greatly influence the soil.

Deforestation may have different results, depending upon the character of the country and the amount and distribution of the precipitation. In the North German plains, with evenly distributed precipitation through the year, a cleared forest may reappear by itself within 100 years if left alone. In the Mediterranean section, because of the rugged relief and precipitation concentrated during the winter, a forest once destroyed may not easily grow again. Basutoland, in the headwater region of the Oranje River in South Africa, is mentioned as an example of destruction caused by deforestation, also as an example of still further destruction by overgrazing of grass covers which formed after the deforestation.

The book contains a bibliography of 117 entries, mainly German.

433. Habermaas, Fritz, Geschiebeeinwanderung in Werkkanäle und deren Verhinderung (Bed-load entry into working canals and its prevention): Wasserkraft und Wasserwirtschaft, 30. Jahrg., 9. Heft, pp. 97–103; 10. Heft, pp. 111–116, 1935.

The author discusses briefly the principal formulas pertaining to the problem of scouring and spiral movement of water and reviews the results attained by other investigators. After that he proceeds to describe his model experiments, in which painted brown coal was used in 24 different model arrangements with stationary beds. On the basis of these preliminary tests seven models with movable beds and twice the size of the first were constructed for the main experiments.

The points to be investigated were

1. The influence of the discharge of the river on the entry of bed load, with a constant water level and a constant flow in the intake.

2. The effect of raising the sill and the effect of a bottom outlet next to the canal intake.

3. The effect of various arrangements for keeping bed load out of the canal.

The models are described in detail with illustrations, and the results obtained are given in tables and diagrams on the basis of which the above questions may be answered as follows:

1. If the canal branches off on the outside of a river bend, the entry of bed load is prevented by the spiral movement in the river, which is away from the bend formed by the intake. The prevention of bed-load entry will be greater the sharper the bend and the greater the discharge in the river.

If the intake is on a straight part of the river, the entry of bed load into the canal will increase with increased discharge in the river.

2. Only for supplementing an already effective curve action can a bottom outlet in the weir on the side next to the canal intake be of service. If the curve action is small, then a cross sill at the head of the canal with a flush outlet will help. However, care should be taken not to form any eddies at the canal intake. At an intake from a straight part of the river, flush outlets under the intake sill to the tailwater are required, but a sufficient difference in head and tailwater levels is necessary even at high water. If it is not available, then only an artificially created bend in the river can help, provided the intake is placed at the outside of such an artificial bend.

The author stresses the necessity of checking all proposed hydraulic projects by suitable model experiments. He cites instances where the results of such model experiments were successfully applied to related problems. For example, the above-described experiments were made in connection with a water-power project, but the results obtained were utilized also in solving a storm-sewer problem.

The author also gives the caution that models with stationary beds may give results opposite to those obtained from models with movable beds.

434. Hjulström, Filip, Studies of the morphological activity of rivers as illustrated by the River Fyris: Upsala Univ., Geol. Inst., Bull., vol. 25, pp. 221–527, 1935. Written in English.

The first half of the paper contains a review of the present knowledge of river hydraulics, bed load, suspended matter, and erosion by flowing water.

The last half of the paper gives the results of a thorough investigation of the hydrology and degradation of the drainage basin of the Fyris River in East Sweden.

Some of the conclusions are as follows:

1. The river is changing little in depth and width.

2. From each square kilometer of the drainage basin the river transports annually 4.6 metric tons of suspended matter and 51.5 metric tons of dissolved matter (mostly lime substances).

3. Denudation takes place mostly between creeks—that is, through ablation—and amounts to 0.037 millimeter a year (at a specific weight of 1.5 for loose material).

Tables of data and an 11-page bibliography are given at the end of the paper.

437. Meyer-Peter, Eugene, Favre, Henry, and Müller, Robert, Beitrag zur Berechnung der Geschiebeführung und der Normalprofilebreite von Gebirgsflüssen (Contribution to the calculation of the bed load carried and the normal width of profile in mountain streams): Schweizer. Bauzeitung, Band 105, Nr. 9, pp. 95–99; Nr. 10, pp. 109–113, 1935.

The problems to be solved are stated as follows:

(*a*) Calculation of the annual bed load of a mountain stream with an artificially stabilized channel.

(*d*) Determination of the longitudinal profile of a regulated mountain stream in which the annual bed load is known and the cross section is assumed, or the determination of the cross section from a known bed load and longitudinal profile.

Existing formulas are revised and amended, after which the authors consider the problems solved in principle, but admit that in all the details these problems cannot yet be solved by strictly mathematical methods. For certain questions the assistance of experiments and measurements in nature is required, especially in regard to the change in the roughness coefficient and the cross slope of the average cross section as a function of the bed load and of the average diameter of the grains. Numerical values for bed-load attrition should be determined. The article contains illustrations and diagrams.

439. Riecke, H. J., Nationalsozialistische Wasserwirtschaft unter besonderer Berücksichtigung der landwirtschaftlichen Wasserwirtschaft (Nazi water economics with special reference to agricultural water economics): Kulturtechniker, Jahrg. 38, Heft 4, pp. 299–326, 1935.

This article is a condensed version of a paper published in Deutsche Landeskulturzeitung, Band 4, Heft 6, June 1935.

A brief description of German water economics from ancient times to the beginning of the Nazi régime is given.

The gradual change of Germany to a world power is pictured and with it the growing control of water by industrial interests, so that it became more and more difficult to obtain water for agricultural purposes during low-water periods.

Flood-protection measures are considered unsatisfactory because many German rivers carry 5,000 cubic meters a second and over during periods of high water, whereas their low-water flow may be only 100 to 200 cubic meters a second.

An area of about 10,000 square kilometers of cultivated land is flooded every year.

In general, the interests of the peasants were ignored during the industrial growth, and the tragic results of the late war are principally attributed to this period of neglect of home agriculture during which imports of foodstuffs were available at attractive prices and easily balanced by increased exports of manufactured products.

In the second and third chapters the author calls attention to the economic importance of Germany's water resources by mentioning that

1. One kilogram of dry harvest substance requires from 300 to 700 kilograms of water during its period of growth.

2. According to Dr. Schroeder, the grain harvest alone in 1933 consisted of 25,000,000 metric tons of grains and 45,000,000 metric tons of straw, which together required 24,000,000,000 cubic meters of water.

3. During the time of growth the quantities of precipitation required for crops are, grains, 300 millimeters; roots, 600 millimeters; meadows, 600 millimeters. The average annual precipitation in Germany is 660 millimeters.

4. The ideal precipitation is lacking for about three-quarters of the meadows and pastures and one-quarter of all cultivated fields.

5. For future and more intensive soil cultivation, adequate water supply is of great importance, and therefore effective planning may require a readjustment of water utilization based on the following considerations:

(*a*) Wind may be substituted for water power or fuel power.

(*b*) Railroads may be substituted for canals. A suitable canal costs about 1,500,000 Reichsmarks per kilometer, whereas a double-track railroad costs only about 300,000 Reichsmarks per kilometer.

(*c*) Industrial plants may have to be relocated.

(*d*) There is no substitute for the water required for agricultural purposes, and soils are fixed in certain localities.

(*e*) The aim of the Nazi regime is to make Germany self-sufficient so far as food and fodder are concerned.

(*f*) National defense measures are necessary, such as a provision for artificially flooding certain areas to prevent invasion and the production of sufficient food and raw materials in time of war.

(*g*) Water-utilization and soil-improvement projects are important means for relieving unemployment.

(*h*) Undertakings for the amelioration of agricultural soil awaken the consciousness of the inseparable tie between the nation and the soil.

(*i*) Regulated water economics and agriculture give security not only to the farmer but to the whole nation.

(*j*) The best possible utilization of water resources is the ultimate aim.

In the last chapter the main problems of agricultural water economics and the methods for their solution are outlined as follows:

1. *Protection against floods, high water, and soil erosion.*—Besides the numerous direct and indirect measures the organization of high-water warning service and high-water forecasts is advocated.

2. *Securing the ground-water requirements for agriculture.*—By preventing too great a ground-water drain from agricultural and forest areas and by the construction of barrages, reservoirs, and ponds, which not only reduce the peak of high waters, but also raise the ground-water level and regulate the run-off. The assistance of scientific research will be required for systematic determination of ground-water supplies and natural drainage areas.

3. *Artificial drainage.*—About 8,000,000 hectares of cultivated land and 2,000,000 to 3,000,000 hectares of moors are not sufficiently drained. Receiving reservoirs for such drainage must be provided.

4. *Artificial irrigation.*—About 11,000,000 hectares of cultivated land and meadows require irrigation. The utilization principally of small streams for this purpose will be required.

5. *Prevention of pollution and purification of surface and underground waters.*—Official river-inspection and pollution-control associations should apply greater care than they have up to the present. Purification processes should be improved, watched more closely, and subjected to stricter requirements.

6. *Agricultural utilization of sewage.*—Of the 65,000,000 inhabitants, 35,000,000 are provided with sewerage systems, but the sewage of only 5,000,000 is utilized for agriculture. If all sewage were utilized, 800,000 hectares of waste lands could be made available, and the yield of the old cultivated land could be doubled. This would (*a*) prevent pollution, (*b*) improve fishing and water sports, (*c*) make Germany more independent in food supplies and fodder, (*d*) prevent soil exhaustion, (*e*) increase food supplies of cities in wartimes, and (*f*) prevent the destruction of fertile elements by biologic treatment processes. The fertilizers thus wasted have a value of 300,000,000 Reichsmarks a year.

The method employed by the city of Leipzig is mentioned as an example of rational disposal of sewage. The sewage is carried through pressure pipes to distant agricultural districts, where irrigation and sprinkling systems distribute it without causing a nuisance.

7. *Restitution of international rights in the field of water economics.*—On this last point the accomplishments of the Nazi régime are noted, and attention is called to the appropriations for promoting water economics and land improvements by the Reich, the Provinces, and credit institutions, which rose from 46,000,000 Reichsmarks in 1932 to 382,000,000 Reichsmarks in 1934.

The German water-economic and land-improvement tasks are considered one of the most important, most difficult, and most patience-requiring problems of the Nazi State. It will require decades to accomplish them, but if the State succeeds by its water economics in meeting the requirements of agriculture, industry, and the trades for further development, then one of the most important foundation stones for the economic reconstruction of the Fatherland will have been laid.

440. Rinsum, Anton Van, Der Abfluss in offenen natürlichen Wasserläufen (Discharge in open natural watercourses): Mitt. aus dem Gebiete des Wasserbaues und der Baugrundforschung, Heft 7, 34 pp., Berlin, Wilhelm Ernst & Sohn, 1935.

This paper presents some of the results of 15 years of research.

The formulas developed by Jasmund, Bazin, Hessle, Hermanek, Krey, Beyerhaus, and Forcheimer are briefly analyzed and criticized.

It is indicated that investigations of channel discharge should take as their starting point the velocity relations at individual points in the cross section and that the vertical velocity curve is of special importance. The latter should form the basis for the interpretation of the discharge laws for the whole cross section.

The mean velocity v_m obtained from the equation $v_m=\frac{Q}{F}$, where Q equals discharge and F equals area of cross section, is of interest only in roughly evaluating the characteristics of a river channel. For example, it may be said that a lowland river has a mean velocity of 1 meter per second, while a steep mountain stream has a mean velocity of 3 meters per second.

In this paper a formula is developed for velocity at any point in the vertical, which utilizes the depth of the channel, the longitudinal slope, and certain coefficients.

A discharge formula should consider the velocity at individual points, as is done in stream gaging, and then should sum up the individual partial discharges as indicated in the formula

$$Q=\Sigma v.\Delta F \qquad (1)$$

The following formula for velocities in the vertical is given:

$$v_s=K_s\sqrt{t_o J} \qquad (2)$$

in which v_s=velocity at the bottom.
t_o=total depth.
K_s=coefficient dependent on bottom conditions.
J=longitudinal bottom slope.

The vertical velocity curve is considered to be a quarter-ellipsoid and the difference between the bottom velocity and the velocity at any depth t is given by the formula

$$v_1=\mu\sqrt{(2t_o.t-t^2)J} \qquad (3)$$

in which μ=coefficient.

Formula 2 is modified in that v_s is considered to be the velocity at a point very close to the bottom and that there is a distance c from the zero point on the vertical velocity curve to the bottom such that

$$t_o = t_{max} - c \tag{4}$$

The velocity v at any point in the vertical is expressed by the formula

$$v = v_s + v_1 = K_s\sqrt{t_o J} + \mu\sqrt{(2t_o.t - t^2)J} \tag{5}$$

The unknowns are combined into a coefficient μ_1 with the result that

$$v = v_s + \mu_1\sqrt{2t_o - t}\sqrt{t} = v_s + \mu_1.f(t) \tag{6}$$

The characteristics of K_s and μ are studied and values derived from actual data. A formula for the discharge is developed in the form

$$Q = \beta K_m\sqrt{J}\int_0^b t_o^{\frac{3}{2}} db$$

in which β = coefficient derived from actual data and is always less than unity.
K_m = coefficient dependent on bottom conditions and is assumed to be the maximum value of K_s.
b = width of section.

441. Sapper, Karl, Über Bodenbewirtschaftung der Erde (On soil economics of the earth): Petermanns Mitt., Jahrg. 81, pp. 350–357, 1935.

The first half of this paper discusses the utilization of soil by man up to the present time. The protection of vegetation against soil erosion is described briefly. Primeval tropical forests are found to be the best protectors of soil, as soil strata as much as 5 meters thick may be found under such forests, while many surfaces covered with low-growing grasses cover a soil layer of only a few centimeters. Thus the forest is considered the best collector and protector of soil, and it would be more so if not hampered in regions with plentiful rainfall by soil movements, landslides, and devastating storms.

The presence of insects and animals increases denudation, by robbing plants of their leaves or by undermining the ground, thus facilitating soil movements.

Attacks on soil on the largest scale are made by man. The amount of denudation caused by flowing water is dependent upon the condition of the soil, which in turn determines the resistance to erosion.

In 1902 the author made interesting observations in Guatemala after the eruption of the Santa Maria volcano, when large areas were covered with fine dark ashes while other areas were sprinkled with little pieces of white pumice. The first rain after the eruption indicated that the ashes formed an impermeable layer, and on these ash fields were formed millions of channels, which rapidly became deeper and which carried enormous masses of the erupted material downward, while the rising rivers carried a thick black mixture.

The pumice-covered areas, on the contrary, absorbed the rain like a sponge and, as a rule, did not form gullies for years and there was no run-off except occasionally, when, because of too large a water content, some of the masses of pumice broke loose, with devastating effects.

Slope and wind effects are considered briefly.

Planned soil conservation and soil development are the most important requirements of a far-sighted population policy.

Under primitive conditions man's influence on soil was insignificant. The peril became greater when the cultivation of crops and raising of herds started and when owing to more secure and more plentiful food supplies, mankind started multiplying more rapidly.

Primitive methods of soil cultivation and planting are reviewed, including hand planting, stick planting, digging, primitive terracing, dry plowing, wet plowing, and hoeing. Denudation in connection with these various methods is discussed, including the Vosges terraces, where after the harvest the eroded soil has to be carried back from the lower terraces to the upper ones. Denudation in Colombia, Africa, Brazil, and the United States is briefly discussed.

The conclusion is reached that during a thousand years of soil cultivation in Europe and southern and eastern Asia on only slightly sloped and carefully cultivated fields, a balance has been reached between the formation of new weathered soil in the subsoil and denudation by water, wind, and gravity. In other parts of the globe, especially in the new countries, owing to thoughtless activity of man, denudation over wide areas is greatly overbalancing the formation of new soil, frequently to such an extent that in places the productive soil has almost disappeared. The conditions in the United States are reviewed.

The second half of the paper covers planned soil cultivation, the important points of which are:

1. Proper soil conservation can be effected only through government regulation.
2. A thorough knowledge of the country's soils and their distribution is necessary.
3. Irrigation, drainage, and reforestation possibilities must be studied.
4. Soil, forest, and water planning must be coordinated.
5. International understanding and agreements are necessary to effect a truly rational soil-conservation program based on a rational distribution of agricultural production, in which climates, soils, and consumption are considered.

The author, however, does not believe that an international understanding is possible in view of the nationalistic attitude of individual nations.

In conclusion, a warning is sounded that in eastern and southern Asia overpopulated regions are located close to underpopulated European colonies, where enormous areas are still undeveloped, but no immigration is permitted. This has led to demands for a reshaping of international rights. The storm clouds gathering in eastern Asia may greatly affect European states.

443. Schoklitsch, Armin, Stauraumverlandung und Kolkabwehr (Silting of reservoirs and protection against scouring), 178 pp., Berlin, Julius Springer, 1935.

The chapter on "Bed load and its transportation" outlines in a general way the properties and movement of bed load and suspended matter, and gives data for various rivers. The influence of ice on run-off is also covered.

The chapter on "Silting of reservoirs" covers also the silting of the river before it reaches the reservoir and the silting below the dam.

The chapter on "Protection against scouring and on energy dissipators" is the most extensive and covers different types of energy dissipators and their characteristics. The results of numerous experiments are given.

444. Sedlmeyer, Karl, Erosionserscheinungen im Tuffgebiet Karpaten-Russlands (Erosion phenomena in the tuff district of Carpatho-Russia): Petermanns Mitt., Jahrg. 81, pp. 63–64, 1935.

This is a short article based principally on a paper by Dimitri Andrusov in Věstník státního geologického ústavu Československé Republiky, Ročník 7, 1931.

The main tuff district lies between the Theiss and the Latorica and is divided into a westerly and an easterly section by the Borsava River, which has formed a broad meandering channel and a wide flood plain. This river is not regulated in any way.

The erosion phenomena in the easterly section are especially impressive. In the first phase a small depression appears, which then shapes itself into a narrow channel, usually in the direction of the slope. In this state the channels or gullies develop a distinct headwater pattern. With the deepening of the channels, the headwater channel broadens simultaneously and is then transformed into separate channels. These are separated by very thin but steep partition walls, which are peculiar to the tuff districts. Such erosion channels have a maximum length of 700 meters and maximum depths of 15 to 20 meters.

The causes of these erosion channels are found in the petrographic character of the rocks and also in the hydrologic conditions of this district. The tuff here has a red-brown color, is well mixed with pebbles, and forms an undulating hill country. The softness of the material favors the development of long channels. The summer heat dries out the material that has been moistened by spring rains and forms cracks on the surface, which also facilitate erosion.

Agricultural settlements in this district are threatened by the sediments which are carried down by the streams and which devastate the fields. During periods of high water the main street of the village forms a creek, so that in summer wide rows of deposited rocks may be seen lining the village and, as at Cengava, surrounding the church.

The authorities are trying to resist the devastating action of erosion by dams of poles, barbed wire, and sod construction, as well as by concrete walls. On the slopes of the gullies locust trees are planted, and an attempt is made to cover the slopes with forests. All these attempts to prevent erosion seem to be futile, as long as the Borsava River itself is not regulated.

447. Walther, Johannes, Einführung in die deutsche Bodenkunde (Introduction to German soil science): Verständliche Wiss., Band 26, 172 pp., 1935.

The paper gives first a description of geologic interrelations, beginning with a brief introduction to historic geology; climates of prehistoric time, with a new theory of glacial periods, which considers distant shifting of the poles, lasting mild climate when a pole is located on oceans, glacial-period climate when a pole is located on a continent; and rainy periods during high sun radiation.

Additional subjects covered include erosion by rivers and forming of terraces, screes formed at the foot of precipices and their movement, loess and dust and their action in connection with soil formation, settling of northern Germany, influence of climate on the northern races, indogermanic sin-flood legend, essentials of meteorology and climatology, frost action, movement of underground water, wind action in arid and humid sections, color of soil, formation of soil horizons, soil profiles, and types of soil.

The examples refer entirely to conditions in Germany, and a special chapter covers the soil districts of Germany. Another chapter covers mineral resources of Germany.

This abstract is based on a German notice in Zeitschr. prakt. Geologie, 43. Jahrg., page 111, 1935.

448. Wassiliew, Charakteristik der Sinkgeschwindigkeit von Flussablagerungen (Characteristics of settling velocities in river silting): Wasserkraft und Wasserwirtschaft, 30. Jahrg., 23. Heft, pp. 271–278, 1935.

The author first states the formula:

$$X = \frac{V}{V_B} H_o$$

in which X = length of settling basin.
v = average velocity in average cross section of settling basin.
V_B = settling velocity of separate particles.
H_o = total depth of current.

Detailed formulas as worked out by 19 different authorities are reviewed and a table giving velocities for different grain sizes as computed by the 19 formulas is presented. It is quite evident that the results are not consistent, for some of the variations amount to several hundred percent.

These formulas are criticised principally because most of them ignore the interior friction of the liquid media.

A table is prepared in which the grain-settling velocities from actual experimental data are compared with results obtained by 17 other authorities. The table gives values for settling velocities in both clear still water and in turbid water.

Further tables covering temperature and viscosity are given, and the relations between d (diameter of grain) and v (velocity) in clear and turbid waters are given for $d=0.06$ to 0.10 millimeter.

The paper is a brief summary of extensive research data obtained during laboratory experiments at the Russian State Research Institute for Water Supply, Sewerage, Waterworks, and Engineering Hydrogeology.

The ultimate formula developed for turbid water is

$$v=0.17642\ g\left(\frac{\sigma_1-\sigma}{\eta}\right)\left[\frac{d}{(2)\ (10)}\right] \quad \text{millimeters per second.}$$

where g = gravity acceleration.
σ_1 = absolute specific weight of falling particle.
σ = density of liquid medium.
η = viscosity coefficient of the liquid medium.

451. Knoche, Walter, Zur Entstehung der Wüste Sahara (On the origin of the Sahara Desert): Forschungen und Fortschritte, Band 12, p. 24, 1936.

A review is made of the possible combination of causes such as changes in the geoplanetary climate and changes in surface climate—that is, soil conditions.

There are indications that the Sahara was once covered with vegetation.

Mention is made of the discovery of rock pictures, which H. Obermaier attributes to about 4,000 B. C. These rock pictures represent domesticated goats with neck collar and the holy disk between their horns. The deduction is made that between 4,500 and 4,000 B. C. the domesticated goat spread from east to west over the whole of North Africa, and that because of the fast destruction of vegetation, which was struggling against the drought, the formation of the desert was facilitated.

It is considered possible that in an earlier period the deserts of western Asia were similarly formed by the advance of goat nomads from central Asia.

There is a possibility that the introduction of goats and not a strictly geoplanetary change in climate was the cause of the desert formation. It is a well-known fact that the goat is a destroyer of vegetation, and if a region is overstocked with animals that graze closely, considerable districts may be denuded and form small deserts, which themselves may contribute to the devastation of other sections.

452. Kobelt, Karl, Der Rhein und seine Probleme (The Rhine and its problems): Schweizer. Bauzeitung, Band 107, Nr. 8, pp. 87-88, 1936.

This article is a review of a paper submitted by the author before the Sektion St. Gallen des Schweizerischen Ingenieur- und Architekten-Vereins on January 9, 1936.

The political, economic, and technical aspects of the problems are covered.

The problems are classified as prevention of damage, utilization of water power, and navigation. From its source to the Bodensee the river is more dangerous than useful. Utilization of the water power on that stretch would require large reservoirs because of the variable run-off. The devastating powers of the wild mountain torrents must be dissipated by terraces that will hold back the debris. Farther down, the valley widens and the slope decreases, and there arose the danger of silting. The building of dikes was required. The dikes at the Swiss bank were increased in height in 1928, and the danger from silting was temporarily averted; but each year the bed of the river increases in height by 10 to 20 centimeters. Should the middle channel become filled, the river will start meandering between the dikes and attack them. Dredging can prevent the danger only temporarily. A permanent remedy must consist in stabilizing the channel so that all the bed load is transported.

In the hydraulic laboratories of the technical college at Zurich thorough model experiments were made on the transportation of bed load by the Rhine. The results of these experiments may today be applied to the actual river. It would, however, be necessary to complement these experiments by measurements on the river. Thorough tests will require at least 2 years.

In the model experiments different proposals for regulating the transportation of bed load were tested. The following arguments are considered:

1. The river bed can be allowed to determine its own longitudinal profile, but the dikes must be raised correspondingly. The objections to this are that the lands below the dikes would become swampy and that the dikes built on peat soil should not be burdened more than they are now. Settling of the dikes may lead to a catastrophe.

2. A change in the discharge profile could not be brought about by raising the control weir of the center channel, which is already too wide, but could be effected by narrowing the center channel by 20 to 40 meters. This would be very costly.

3. A cheaper method would be to dredge the silt continually. This measure is technically unsatisfactory, and in a short time it would not be possible to dispose of the material without costly transportation.

4. Narrowing the center channel would not be effective in the long run without a simultaneous decrease of bed load by extended regulation of the mountain torrents at the source. A further supply of bed load on the present scale would, within a discernible time, advance the estuary of the Rhine in the Bodensee farther into the lake, and the longitudinal profile would be still further flattened.

The Bodensee fulfills a very important task. It receives the bed load of the Rhine and regulates the run-off. The high-water peaks of the Bodensee come about 5 days later than those of its tributaries. The Bodensee also causes flooding, because its outflow is not sufficient during high inflows. Lake floods have a different character from river floods. They last longer but do not deposit silt.

To improve the discharge of the Rhine there has existed since 1926 a project for regulating the Bodensee. This covers principally the dredging of the too-small discharge channels at Gottlieben and Stein, on the Rhine Besides that it includes a weir near Hemmishofen for regulating the low-water stages. This regulation of the Bodensee would also result in better operation of the Rhine power plants, by storing the superfluous summer water for the winter.

From the Bodensee to Basel the Rhine flows in a deep channel. It does not carry bed load any more, and its course is quite even.

454. Strele, G., Fünfzig Jahre Erfahrungen bei der Wildbachverbauung in Österreich (Fifty years' experience in mountain-torrent regulation in Austria): Wasserkraft und Wasserwirtschaft, 31. Jahrg, 6. Heft, pp. 61–65; 7 Heft, pp. 77–80, 1936.

This article presents a review of torrent-regulating methods in the last 50 years. In the early days installations on the lower parts of streams were constructed for protecting directly the threatened areas. These afforded only temporary protection. In Tyrol, however, by the first half of the sixteenth century, regulating installations were constructed in the source districts, with very good results. These installations were so effective near Brixen that by the middle of the seventeenth century these inaccessible barrages had been forgotten and were not rediscovered until 200 years later. Meanwhile they had been effectively protecting the formerly exposed areas.

Mountain torrents cause more damage by the bed load than by the water carried. For protection against bed load, barrages, settling basins, and gravel catch basins are built. However, after these storage places have become filled, their effectiveness largely ceases. On the other hand, cross, longitudinal, and shell structures for combating the loosening and eroding forces of the water, and soil-protection, sod-growing, afforestation, and other soil-binding measures retain their effectiveness permanently.

Protective construction on the lower part of the streams is resorted to only for direct protection of threatened areas.

Construction methods and materials have changed. Fifty years ago transportation facilities to the mountain valleys were more scanty than today. Therefore, local materials, such as stone, timber, and brush, were used. Timber construction was utilized to a great extent after the floods of 1882 and 1885 in the Anrainer district, partly because suitable stone was scarce, and partly to provide income for the inhabitants, who had suffered considerable losses through the floods. Besides that, timber structures have the advantage of a certain flexibility and yield, have great resistance against damage, and are more rapidly executed by local labor. The great disadvantage of timber construction is its rapid decay. Gradually such construction was reduced and confined to installations that are permanently covered with water or to damp and spongy places where in time increased vegetation renders the structures unnecessary. Recent declines in timber prices have led in some sections to combination structures in which the side exposed to the air is covered with a thin concrete wall. Such a structure was first built experimentally in 1905 and has stood up well. The greater part of the early construction was executed with stones; at first, dry stone work without mortar, and then gradually more and more cement mortar was employed, as this saved the cutting of stones and at the same time decreased the required thickness of the dams.

Since 1899 concrete construction has increased, as it required less specially skilled labor and the materials needed could be obtained through improved transportation facilities. Since 1910 reinforced-concrete walls have been used to cover existing timber structures.

Before sufficient experience has been gathered slender barrages of reinforced concrete require caution in design and construction, especially where heavy water and bed loads are passed or where seepage may take place.

Brushwood construction has been successfully employed for a long time, but this construction is suitable only for low cross dams or longitudinal dikes where the water velocity is not high.

At the foot of the bank slope a cement covering is recommended to form a limit line for the vegetation. Since the beginning of the present century wire gravel containers patented by Italian engineers have also been used in Austria. In some places locally made wire-mesh containers have been used.

The author gives much advice in regard to the points where special caution is required, such as the wear and tear of structures under different conditions, and methods of protecting concrete barrages with stone crowns, planking, rails, plates, etc.

Damage of structures is mainly attributed to washouts or seepage. Methods of protection under different conditions are briefly suggested. The main stress is laid on protection against soil movement by binding the soil, employing if necessary only temporary methods such as seeding, sodding, then quick-growing trees such as willows, poplars, alders, locust trees, and sand thistles, and later on substituting more choice varieties of trees.

Extensive afforestation has been suggested by some as an ultimate method for curbing torrents, but the author finds this method unsuitable for Austria and considers that proper regulations applied to existing forests are more important than afforestation. Forests require decades before they become effective in preventing floods and debris movement. Therefore, Austria's policy has been first to regulate the torrents and then to apply cultivation measures for completing and securing such regulation.

VOCABULARIES ON SOIL EROSION, SILT, AND RELATED SUBJECTS

FRENCH-ENGLISH

abatage—removal of broken ground.
abée—millrace, flume.
abîme—abyss.
accolé—joined.
accolement—union, composition.
accore—steep.
acheminement—step.
affaissement—subsidence.
affleurement—outcrop.
afflux météorique—total volume of precipitation on a basin in a given period of time.
affouiller—to undermine, to scour.
agoge—gutter.
aigu—sharp.
aire—area.
allaise—sandbank.
alluvions—alluvium; sand, gravel, etc., deposited by flowing water.
amas—accumulation, mass.
amont—upstream.
apport—deposit, drift.
araser—to level.
areg—sandy deserts (plural of erg).
arène—sand, gutter.
argile—clay.
arpenter—to survey.
assécher—to drain.
assise—bed, horizon.
assolement—rotation of crops.
âtre—hearth.
atterrissage—landing.
atterrissement—deposition of sediment.
auge—channel, flume.
aval—downstream.
avalasse—flood.

bajoyer—river-wall.
barrage—dam across a valley.
bassin d'alimentation—tributary area.
bassin hydrographique, bassin hydrologique—drainage area or drainage basin.
berge—levee, steep bank, flank.
bialet, bialière—irrigation canal.
bief—reach, millrace.
boisement—afforestation.
bombement—swelling.
boucle—loop of a meandering river.
boue—mud, slime.
bourbier—puddle, mud.
bourrer—to ram, to pack.
brassage—mixing.
briser—to break up.
brouillard—fog.
brousse—bush, undergrowth.
buisson—bush, thicket.
buse—flume, nozzle.
busqué—curved.

cadastrer—to survey.
caduc, caduque—decayed.
caillou—pebble, boulder.
cailloutis—gravel.
calcaire—limestone.
carié—decayed.
carré—square.
cassant—brittle.
cassure—fracture.
charriage—transport.
chenal—channel.
chevauchement—overlapping.
choc—shock, blow.
chute—fall.
clapier—talus, aluvial cone.
coefficient d'ecoulement—run-off coefficient.
colmatage—silting.
concasser—to crush.
coteau—slope.
couche arable—topsoil.
coulisse—groove.
crever—to burst.
crible—sieve, screen.
crique—crack, creek
croûte—crust.
cru—raw, crude.
crue—growth, flood.
culée—abutment.
cuve—vat, tank.

débit—performance, delivery, yield.
débit météorique—volume of water brought to a basin by precipitation during a unit of time.
déblaiement—clearing, corrasion.
déboisement—deforestation.
déborder—to overflow.
débouché—outlet.
débris—debris.

décaper—to clean, to scour.
décharge—discharge.
déchéance—decay.
décollement—parting.
décombres—rubbish.
décrue—decrease.
dégel—thaw.
dégraisser—to scour, to carry off soil.
dénoyer—to unwater.
dépôt—deposit, settling.
dépouillement—analysis.
déprimé—flattened.
désagrégation—disintegration.
dessin—drawing, design.
détente—expansion.
détournement—diversion.
détroit—strait.
dévers—tilt.
déversement—discharge, junction, warping.
déversoir—weir.
dévis—estimate.
diapason—range, scale.
dief—clay dike.
digérer—to digest.
digue—dike, dam, levee.
diluvium—diluvium; sand, gravel, etc., deposited by inundation.
disette—scarcity.
données—data.
dragage—dredging.
durée—duration.
dureté—hardness.

eau buvable—potable water.
eau d'égouts—sewage.
eau de fonte—water from melting.
eau de source—spring water.
eau douce—fresh water.
eau du jour—surface water.
eau dure—hard water.
eau salée—salt water.
eau sauvage—sheet flood.
eau vive—running water.
ébauche—sketch.
éboulement—landslide, cave-in, rock fall.
éboulis—talus.
écaille—scale.
écarté—remote.
échantillon—sample.
échelle—scale.
éclater—to burst.
écluse—lock, lock gate.
écorce—bark.
écoulement—flow, run off.
écraser—to crush.
écroulement—fall, collapse.
effriter—to exhaust land, to crumble.
égout—drainage, sewer.
éluvial—residual.
emboîtement des terrasses—succession of terraces.
emboîter, s'—to fit in.
embouchure—mouth of a river.
embraser—to set on fire.
émeuler—to grind.
émietter—to crumble.
émousser—to make blunt.
empâter—to enclose.
empêcher—to hinder.
empiéter—to encroach.
enciente—enclosure, wall.
endiguer—to dam.
endogène—endogenetic, igneous.
enduit—coating, layer.
enfuir—to bury.
engrais—fertilizer.
ennoyage—depression.
ensablement—sanding-up.
ensettlement—depression.
entasser—to accumulate.
entraîner—to carry away.
envaser—to silt up.
épaisseur—thickness.
épanchement—discharge.
épanouir, s'—to expand.
éparpiller—to scatter.
éponte—wall (of a dike).
épuiser—to empty.
épure—diagram.
épurer—to purify.
erg (pl. areg)—sandy desert.
espace—space.
espèce—species.
esquisse—sketch.
essai—test, assay.
étage—stage.
étale—spread out.
étalon—standard.
étanche—impermeable.
étang—pond.
éteindre, s'—to die out.
étendu—extensive.
étiage—low-water mark.
étirer—to stretch.
étroit—narrow.
évaser—to widen.

faille—fault.
falaise—cliff.
fange—mud.
fardeau—load.
fendre—to split.
feuillet—flake.
fiche—peg.
filon—vein, lode, dike.
flot—wave, flood-tide.
fond—bottom.
fondre—to melt.
fouille—excavation, pit.
foyer—hearth, focus.
frane—landslip.
friche—waste, fallow.
frottement—friction.
fuite—leak.

galet—pebble, boulder.
gave—torrent.
gazon—turf.
génie civil—civil engineering.
giboulée—shower.
gisement—layer.
glace—ice.
glacis—slope.
glissement—slip.
goulet—gully.
goutte—drop.
gravier—gravel.
grès—sandstone.
gries—gravel.

hautes montagnes—mountains.
hauteur—height.
hauteur d'afflux—depth of precipitation (depth at which rainfall would stand on an area, if it all remained on the surface and was uniformly distributed).
hauteur d'écoulement—depth of run-off (depth at which that part of the rainfall which runs off into the streams from an area would stand, if it all remained on the surface and was uniformly distributed).
houille blanche—water power.
houille grise—wind power.
hypogé—underground.

intempérisme—surface erosion.

jauge—gage.
jusant—ebb tide.

lais—silt.
lavage—washing.
lessivage—leaching.
levé—survey.
levée—rising.
ligne de partage—watershed, divide.
liman—silted estuary, lagoon.
limon—loam, silt, loess.
lise—quicksand.
lit—bed, lamina.
lit majeur—flood plain.
lit mineur—river channel.

marais—marsh.
marée—tide.
marmite—pot, potholes.
marne—marl.
meulage—grinding.
môle—mole, breakwater.
montant—slope.
motte—clod, lump.
mouillé—wet, moist.
moyenne—average, mean.

nager—to swim. to float.
nappe—layer.
neige—snow.
neige fondu—snow water.
niveau piézométrique—water table.
noyage—flooding.
nuage—cloud, mist.
nuée—cloud, storm.

onde—wave.
ondée—shower.
orage—storm.

pan—side, wall.
paroi—side, wall.
partage des eaux—divide.
pays de collines—highlands.
pente—slope.
perte apparente—apparent loss (the difference between rainfall and run-off occurring in the same period of time).
plafond—floor (of a reservoir).
plaine d'inondation—flood plain.
plan d'eau—water level.
plan de niveau—datum line.
plan, dernier—background.
plan, premier—foreground.
pli—fold.
pluie de poussière—dust storm.
pluviomètre—rain gage.

podsol—bleached sand, podsol.
pourri—rotten, rottenness.
poussière—dust.
précipité—precipitation.
profil en long—longitudinal section.
profil en travers—cross section.
puits—well, pit, shaft.

rampe—slope.
rapport—ratio, report, production.
ravin—ravine.
ravine—torrent.
raviner—to erode differentially, to channel.
reboisement—reforestation.
reillère—flume.
relais—relay, silt.
relief—contour of the ground.
remblai—filling up.
remous—eddy.
repli—fold.
restenque—cultivated terrace.
rièze—barren ground.
rigole—ditch, gully, rill.
rivage—shore, bank.
rive—shore, bank.
roche de fond—bedrock.
roder—to grind.
rôder—to rotate.
ronger—to erode.
rosée—dew.
rouille—rust.
ru—small stream, gully.
ruisseau—stream, brook.
ruissellement—work of running water, rainwash.
ruissellement, terre de—alluvium.

sable—sand.
sable femelle—light-colored sand.
sable flottant—quicksand.
sable mâle—dark-colored sand.
sables bouillants, sables boulants, sables flottants, sables mouvants—quicksands.
sablon—fine sand.
samoun—sand storm.
sapement—undercutting.
sapropèle—sapropel, decaying organisms.
sas—sieve, coffer, chamber.
sécheresse—aridity, drought.
seller, se—to settle, to sink.
seuil—sill.
sinuosité—bend (in a river).
sol—soil, ground, footwall (of a vein, fissure, or fault).
sous-bief—back-water.
sous-sol—subsoil.
stade—stage.
strate—stratum.
surface du sol—top soil.

tangue—shell sand used as fertilizer.
tapis végétal—vegetable cover.
tas—heap.
tassement—sinking, settling.
tasser—to pile up, to ram.
terrasse de recoupement—river terrace.
terre végétale—soil.
terreau—soil.
titre—content, grade, fineness.
tourbe—peat.
tourbière—peat bog.
tourbillon—whirlwind, eddy.
trop-plein—overflow, weir.

udomètre—rain-gage.

vanne—sluice.
varenne—waste land.

GERMAN-ENGLISH

Abfluss—run-off, discharge.
Abflussbeiwert—ratio of annual run-off to annual precipitation.
Abflusshöhe—run-off depth.
Abflusspende—run-off volume per unit of area.
Abflussverluste—run-off losses.
Abflussverlusthöhe—run-off loss expressed as a depth.
Abflussverzögerung—run-off delay.
Abflusswasserfracht—material transported with run-off.
Abfolge—origin.
Ablagerung—sedimentation, deposits.
Ablation—ablation; denudation by wind, ice, etc.
Abrasion—erosion by wave action.
Absatz—sediment.
Absonderung—planes of division, joints.
Abspülung—erosion by water.

Abtragung—denudation, erosion.
Ähnlichkeitsgesetz—law of similarity.
Alluvium—alluvium; sand, gravel, etc., deposited by flowing water.
Anpassung—adjustment.
Arm—channel of river.
Art—species.
Ästuarium—estuary.
Aufbau—constitution, building up.
Aufforstung—afforestation.
Aufschotterung—sedimentation.
Ausfällung—precipation, secretion.
Ausflockung—flocculation.
Ausfurchung—erosion by running water (furrowlike).
Ausgangsgestein—parent rock.
Ausgleichsgefälle—grade adjustment.
Auskolkung—excavation, pothole formation by running water, scouring.
Auslaugung—oxidation, leaching.
Ausscheidung—precipitation.
Ausschürfung—scouring, cut.

Bach—brook, creek.
Barren—sand and silt deposits at a river's mouth.
Bergsturz—mountain waterfall.
Beschleunigung—acceleration.
Bestand—consistence.
Bettsohle—bottom of river bed.
Bildung—formation.
Bimsstein—pumice stone.
Blauschlamm—blue mud.
Bleichsand—infertile light-colored sand.
Blocklehm—bed-load clay.
Boden—bottom, soil.
Bodenabschwemmung—soil erosion, soil washing.
Bodenanalyse—soil analysis.
Bodendispersität—soil dispersiveness.
Bodenfluss—soil movement.
Bodenkartierung—soil cartography.
Bodenkunde—soil science.
Bodenlehre—soil science.
Bodenprobe—soil sample.
Bodenverbesserung—soil improvement.
Bodenversetzung—erosion by gravity.
Böschung—slope.
Breite—width.
Bresche—breccia.
Bruch—fracture, fraction.
Buhnen—wing dams, spur dikes, groins.

Corrosion—corrosion by running water, sand, and bed load.

Darg—peat containing mud.
Deflation—erosion by wind or by wind-carried sand.
Deich—dike.
Denudation—joint action of erosion and weathering.
Detritus—suspended matter in river.
Diluvium—diluvium; sand, gravel, etc., deposited by inundation.
Düne—dune.
Durchflussmenge—discharge.
Durchflussprofil—discharge profile.
durchsickern—to percolate.
Durchstich—cut, channel, excavation.

Ebbe—ebb.
Einfang—intake.
Einzugsgebiet—drainage area, area tributary.
Eluvium—the products of weathering at their place of origin.
Entwaldung—deforestation.
Erde—earth, soil.
Erdfliessen—earth movement.
Erdkrume—top soil.
Erdrutsch—landslide.
erodieren—to erode.
Erosion—erosion by running water.
Erosionsbasis—lower limit beyond which erosion cannot take place; baselevel of erosion.
Erosionsrinne—erosion channel.
Evorsion—whirling movement of water.
Exaration—erosion by glacial action.

Falte—fold.
Fanggräben—catch basins, small temporary reservoirs.
Fastebene—peneplain.
Faulschlamm—sapropel, decaying organisms.
Felsbecken—potholes.
Flachland—low land.
Flechtströmung—twist flow.
Flugsand—blown sand.
Fluss—river.
Flussaue—flood plain.
Flussbett—river bed.
Flussgebiet—river basin, drainage area.

Flüssigkeit—liquidity.
Flusskorrektion—river regulation.
Flusskunde—river science.
Flussmündung—mouth of river.
Fluss-sohle—bottom of river bed (sole).
Flusstrübe—suspended matter in river, turbidity of river.
Flut—tidal flow; flood.
Flutgränze—flood limit.
Fülle—binding material of sandstone.

Gang—vein, dike.
Gebirge—mountains.
Gefälle—gradient, slope.
Gehänge—precipice.
Gehängeschutt—hillside waste, screes.
Gekriech—creep.
Gerinne—channel.
Gerölle—pebbles, boulders.
Geschiebe—bed load, transported sedimentary material.
Geschiebeableitung — bed-load deflection.
Geschiebefracht—rate of bed-load transportation.
Geschiebeherd—source of bed load.
Geschiebemenge—bed load.
Geschwindigkeit—velocity.
Gestein—rocks.
Geviertmeter—square meter.
Gewässer—waters.
Gleichgewicht—balance.
Grand—coarse sand, gravel.
Grauerde—humus.
Grund—ground, soil, bottom.
Grundgleichung—basic equation.
Grundlage—basis.
Grundriss—plan.
Grundwasser—ground-water.
Grundwasserstand—underground-water level.
Grus—grit.

Hafen—port.
Halde—accumulation of rock debris.
Herd—place of origin.
Hochflutbett—flood plain.
Hochgebirge—high mountains.
Hochwasser—high water, flood.

Kegel—cone.
Kies—gravel.
Kiesbank—gravel bank.
Kiesel—quartzite, quartz, silica.
Kieselgestein—siliceous rock.
Kieselgur—diatomaceous earth.
Kiesfang—gravel catch pit.
Kolk—depression formed by running water, pothole.
Kolkabwehr—protection measures against scouring at weirs, etc.
Korrasion — erosion caused by wind-blown sand.
Korrosion—gnawing action of running water, ice, or wind.
Kreislauf des Wassers—hydrologic cyle.
Krümmung—bend.

Lagerstätte—deposit.
Längenprofil—longitudinal profile.
Lauf—channel.
Lawine—snowslide.
Lehm—loam.
Leitung—conduit.
Löss—loess.

Massenaustausch—exchange of matter.
Mergel—marl.
Messung—measurement.
Mittelgebirge—highlands.
Mulde—trough.
Mündung—mouth.

Nebenfluss—tributary.
Niederschlag—precipitation.
Niederschlagsgebiet—precipitation area.
Niederwasser—low water.

Oberflächenerosion—surface erosion, sheet erosion.
Oberlauf—upper part of river's course.

Pegel—gage.
Pflanzenbedeckung—vegetation cover.
Podsol—bleached sandy soil in Russia; podsol.
Polje—basin.
Profil—cross section.

Quelle—spring, source.
Quellgebiet—source area (of a river).
Querprofil—transverse profile, cross section.
Querschnitt—cross section.

Rachel—gully, gorge.
Rauhigkeit—roughness.
Rauhigkeitzahl—index of roughness.
Räumungskraft—scouring energy.
Reibung—friction.

Reibungswiderstand—frictional resistance.
Reinigungsbecken—cleaning basin.
Rille—groove, initial stage of a gully.
Rippel—ripple.
Rohton—clay.
Rumpf—body, trunk.
Rumpffläche—peneplain.
Rutschung—landslide.

Sandkorn—sand grain.
Sandverkieselung—silicification of sand.
Sapropel—sapropel, decaying organisms.
Schicht—layer, stratum.
Schichtung—sedimentation form.
Schlamm—wet silt, mud.
Schlammabsatz—silt deposit.
Schlammführung—silt transportation.
Schleppkraft—traction.
Schlick—mud.
Schluff—silt, finest sand dust.
Schotter—gravel.
Schutt—debris.
Schutthalde—talus.
Schutthang—talus.
Schuttkegel—talus fan.
Schweb—suspended matter.
Schwebestoff—suspended matter.
Schwemmkegel—talus fan.
Schwemmstoff—suspended matter.
Sedimentierung—silting, sedimentation.
See (der)—lake.
See (die)—sea.
Seife—placer.
Senkrecht—perpendicular.
Sickerung—percolation.
Sinkstoff—suspended matter, deposit.
Sohle—level, bed (river).
Sole—saline spring.
Spaltung—splitting, diversion.
Stadium—stage.
Staub—dust.
Staubsand—dust sand.
Staubsturm—dust storm.
Stauraumverlandung—silting of reservoirs.
Stauwehre—weir.
Stauwerke—dam works.
Steinschutt—rock debris.
Strom—stream, flow.
Stromgebiet—drainage basin, tributary area.
Strömung—flow.
Strudel—whirlpool, eddy.
Sumpf—swamp.

Talboden—valley floor.
Talsohle—bottom of valley.
Talsperre—barrage, dam across a valley.
Talweg—thalweg (the whole course of a river).
Teich—pool, pond.
Therme—thermal spring.
Tiefe—depth.
Tiefenerosion—gully erosion.
Ton—clay.
Torf—peat.
Trümmer—clastic rocks.
Tupfbau—hand or hoof planting.
Turbulenz—turbulence.

Uferböschung—slope of river bank.
Umfang—perimeter.
Unterboden—subsoil.
Untergrund—underlying rock, bedrock, subsoil.
Unterhaltung—maintenance.
Ursprung—origin.
Urwald—primeval forest.

Verdampfung—evaporation.
Verdunstung—evaporation.
Verlagerung—displacement.
Versickerung—infiltration, percolation.
Verteidigung—protection.
Vertikalgeschwindigkeitskurve—vertical velocity curve.
Verwesung—decomposition.
Verwitterung—weathering.
Vorbehandlung—preparation.
Vorgang—process.
Vorgebirge—promontory.

Waldrodung—deforestation.
Walkerde—fuller's earth.
Wand—wall.
Wasserbau—hydraulic engineering.
Wasserfracht—weight of water, bed load, suspended matter, or ice within a given time unit.
Wasserhaushalt—rainfall, run-off, and evaporation relations.
Wasserkraft—water power.
Wasserlauf—watercourse.
Wasserriss—gully.
Wasserscheide—watershed, divide.
Wasserwalze—eddy, roller, whirlpool.

Wechselwirkung—mutual reaction.
Wehre—weir.
Widerstand—resistance.
Wildbach—wild mountain torrent.
Wirbelbewegung—turbulence, eddies.
Wirbelig—turbulent.
Wirkung—action, reaction, effect.
Wüste—desert.
Wüstung—abandoned land.

Zerfall—disintegration.
Zersetzung—decomposition.
Zerstörung—destruction.
Zustand—state.

RUSSIAN-ENGLISH

аллювий—alluvium.
арык—irrigation canal.
атмосферные осадки—precipitation.

бассейн—basin, reservoir.
батометр—bathymeter, sampler.
берег—bank, shore.
бетон—concrete (cement).
болото—swamp
бочаг—deep place in a stream.
бурный—turbulent.
бык (плотины)—buttress, pier.
бьеф—mill course

вал—billow, wave.
величина—value, size.
ветер—wind.
взвешенный—suspended.
вихорь—whirlwind.
влага—moisture.
влажность—humidity, moisture.
водный режим—hydrologic data on a river.
водовод—conduit, canal.
водоворот—whirlpool, eddy.
водоем—reservoir.
водоемина—pit, gully.
водозабор—water intake.
водомерная рейка—depth gauge.
водомерный—hydrometric.
водомоина—ravine.
водопад—waterfall.
водополье—overflow, high water.
водопровод—aqueduct, canal.
водораздел—watershed.
водоской—reservoir.
водослив—waste weir, water outlet.
водоснабжение—water supply.
водосой—source of water.
водоспуск—flood gate, fish channel, trough.
водостой—water pool.
водосток—water drain.
водостроитель—constructor of hydraulic works.
водоток—channel.
водоточина—seepage through a dam.
водоходный—navigable.
водоходство—navigation.
водохранилище—reservoir.
водяная сила—water power.
воздух—air.
волна—wave.
волнолом—breakwater.
волчок—hydrometer.
ворота—gate.
впадение—mouth of river.
вскат—slope, talus.
выгиб—bend.
вымоина—gully, ravine.
высота—height.

габион—gabion (bottomless wicker basket).
галечник—conglomerate.
галька—pebbles, boulders.
гать—dam, sea wall.
гидравлика—hydraulics.
гидрология—hydrology.
гидротехника—hydrotechnics.
глина—clay, argil.
глубина—depth.
головной—head, top.
головной регулятор—head gate.
гора—mountain.
гравий—gravel.
гребень—crest, watershed.
грунт—ground, soil.
гряда—layer, ridge, bed.

давление—pressure.
дамба—dam, weir.
движение—movement.
дерево—tree.
дерн—turf, sod.
длина—length.
дно—bottom.
дождь—rain.
долина—valley.
донный нанос—bed load, sediment.

драга—dredge.
дюна—dune.

жара—heat.
живое сечение—cross section.

забор—intake.
завал—obstruction, embankment.
заиление—silting.
занесение песком—sanding up.
запруда—barrage.
затопление—flooding.
защита—protection.
земля—earth, soil.
зеркало—mirror, water level.
зерно—grain.

известь—lime.
извилина—bend, meander.
изгиб—bend.
измерение—measurement.
иль—slime, silt.
испарение—evaporation.
истечение—discharge.
источник—spring, source.

камень—stone.
канава—ditch.
канал—canal.
карта—map.
кора—crust.
кремень—flint.
кривая—curve.
куст—shrub, brush.

лед—ice.
ледник—glacier.
лес—forest.
лесная культура—afforestation.
луг—meadow.

море—sea.
мороз—frost.
мост—bridge.
мох—moss.
мутность—turbidity.
мутный—turbid.

наблюдение—observation.
наводнение—flood.
нанос—silt, sediment.
напор—head of falling water.
насыпь—fill (earth).

обвал—cave-in.
об'ем—volume.
облако—cloud.
область—area, district.
озеро—lake.
орошение—irrigation.
осадки—precipitation.
осаждение—deposit.
осевший—deposited, settled.
отверстие—opening.
откос—incline, slope, ramp.
отложение—deposit.
отстойник—settling basin.

паводок—high water.
пастбище—pasture.
пахать—to plow.
перекат—rapids, shallows.
перемычка—narrows.
песок—sand.
пик—peak.
план—plan.
плотина—dam, dike, mole.
плуг—plow.
поверхность—surface.
подводный периметр—wetted perimeter.
подмывание—erosion, underwashing.
подпочва—subsoil.
поле—field.
поперечное сечение—cross section.
порог—sill.
потеря—loss.
поток—flow, stream.
почва—soil.
почвоведение—soil science.
приток—tributary, inflow.
продольный—longitudinal.
прокоп—canal, ditch.
пролет—opening, aperture.
промыв—flush-out.
профиль—profile.
пруд—pond.

равнина—plain, flat land.
размыв—scouring, erosion.
разница—difference.
растение—plant (botanical).
растительность—vegetation.
расход—expense, consumption, value, quantum.
режим—régime, regimen, control.

река—river.
речная область—river basin.
русло—river bed.
ручей—brook.
рыть—to dig.

село—village.
сечение—section (cross-, etc.).
сила—power.
скала—rock.
скорость—velocity.
слизь—slime.
слой—layer.
снег—snow.
солнце—sun.
сопротивление—resistance.
спад—decline.
средний—average, medium.
стена—wall.
сток—discharge, run-off.
суглинок—clayey soil.
сухой—dry.

твердый—solid, hard.
теплота—warmth, heat.
течение—current, stream, flow.
толщина—thickness.
трение—friction.
труба—pipe.
туман—mist, fog.
туча—dark cloud.

углубление—depression, pit.
уклон—slope.
уровень—level.
ускорение—acceleration.
устье—mouth of river, orifice.

хозяйство—economy, housekeeping.
холод—cold.
холостой сброс—waste way.

цемент—cement.

частица—particle.
черпак—bucket.

шандорные брусья—sluice timber.
шероховатость—roughness.
ширина—width.
шуга—ground ice.

щелочи—alkalies.
щит—gate (sluice).
щуп—bottom sampler.

эпюра—diagram.
эрозия—erosion.

яма—pit.

SUBJECT INDEX

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AUTHOR INDEX

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