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THE ATLAS OF WORLD WATER BALANCE

The USSR National Committee of Cartographers

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An extensive programme of international cooperation in the field of hydrology as outlined within the framework of the International Hydrological Decade (IHD) established under the aegis of UNESCO in 1965, included 60 fundamental problems of modern hydrology, a problem of the water balance and water resources being among those considered to be of particular importance.

The problem of water has become of concern lately due to increase of water consumption throughout the world. It is required, therefore, that steps are taken to improve the existing and develop new, more effective methods for investigating and mapping water resources.

At present, a so-called mapping method is widely used in geographical investigations. However, hydrological maps now in use do not always meet the requirements of practice in hydrological estimates and scientific studies. This fact results, to some extent, from incomplete and insufficient development of existing theoretical and methodical bases of hydrological mapping.

The International Guide to Hydrological Mapping to be published within the framework of the International Hydrological Programme will apparently fill the gap.

In 1974, the Atlas of World Water Balance was prepared by Soviet scientists. National IHD Committee in different countries also contributed by sending the results of hydrological observations available.

Although the Atlas of World Water Balance appeared as a supplement to the monograph titled "The World Water Balance and Water Resources of the Earth", it is seen as an independent book on water balance elements, prepared by joint efforts of a large group of specialists in hydrology, meteorology and mapping technology working in scientific institutions under the Hydrometeorological Service of the USSR.

Data on hydrometeorological observations published both in soviet and world scientific literature and in hydrological and meteorological year-books as well as regional maps of water balance elements were used to compile the Atlas.

The State Hydrological Institute, Voeikov Main Geophysical Observatory, Arctic and Antarctic Research Institute took part in collection, processing and scientific generalization of voluminous isolated material as well as in compilation of maps appearing in the Atlas.

The editorial staff headed by V.I. Korzun, the chairman of the International Committee of the International Hydrological Decade (now the International Hydrological Programme), supervised the work.

The programme of the Atlas was worked out in accordance with the structure and contents of the monograph "The World Water Balance and Water Resources of the Earth", taking into account the availability of hydrometeorological data necessary for map compilation and the purpose of the Atlas.

The above Atlas contains 65 maps showing water balance elements; these maps are more minute than those published on the subject earlier. 6 maps of the World to the scale of 1:50 000 000, 8 maps of the Europe to the scale of 1:10 000 000, 52 maps of Asia, Africa, North America and South America (8 maps each) to the scale of 1:20 000 000, 8 maps of Australia to the scale of 1:15 000 000, 7 maps of the Arctic and 4 maps of the Antarctica to the scale of 1:20 000 000 are included. A short explanatory note is also presented.

A specific purpose of the Atlas both as a mapping supplement to the monograph and as an independent complex mapping book determined the choice of projections and map scales to ensure a detailed and accurate graphic reflection of hydrometeorological information related to the entire globe.

All maps of continents, except for Antarctica, are

azimuthal equal-area projections which ensure easy use because the scale of areas remains constant.

The map of the World is a polyconic projection developed by TsNIIGAIK while the maps of the Arctic and the Antarctic are equidistant azimuthal projections by Postel.

Mathematical and geographical backgrounds of the maps included correspond completely to the thematic character. Geographically, the maps are compiled in accordance with contemporary requirements in order to ensure best conditions for comparing phenomena and objects appearing on different maps but considered as a single complex.

The unity of projections and uniqueness of scales in geographic background of the maps of The Atlas of World Water Balance and that of orographical maps of The Atlas of the World, ensure favourable conditions for comparing special maps of The Atlas of World Water Balance between the maps included in the Atlas as well as with orographical maps of The Atlas of the World while making physico-geographical analysis of water balance elements for the purpose of studying regularities of the spatial distribution of these and for understanding the relationships between water balance elements and with the elements of geographical landscapes.

The Atlas contains the maps of the following hydrometeorological elements which characterize the water balance and water resources of continents and of the World as a whole:

- annual total precipitation;
- intra-annual distribution of precipitation;
- annual sum and intra-annual distribution of evaporation;
- annual value and intra-annual distribution of evaporation;
- mean annual run-off;
- intra-annual distribution of run-off;
- run-off coefficients;
- excess and deficit of river water resources.

One of the major methodological peculiarities of compiling maps for The Atlas of World Water Balance is that to compile maps of main components of water balance elements, such as precipitation, evaporation and run-off, data on mean many-year values obtained using independent methods were used with further agreement of pictures of these elements appearing on the maps themselves.

The water balance elements fitting was performed at the points in $1-2^{\circ}$ by latitude and longitude and in 30' in the highlands.

Closures of the balance, not exceeding in the main 10% of total precipitation for the plains and 20% for the mountains, indicate rather high accuracy of the constructed maps.

To a considerable extent, the balance fitting was conductive to the corrections introduced into measured precipitation, and determined by the methods developed in the Main Geophysical Observatory for gauges applied in different countries.

With the insufficient information on the values of water balance when constructing the maps the indirect methods have found a wide application for estimating the water balance elements and, in particular, determination of runoff from meteorological data on precipitation, evaporation and evapotranspiration with regard to physico-geographical features of a particular region of the globe. Also when constructing the maps there were widely used the methods of geographical interpolation and extrapolation, particularly, for unstudied and insufficiently explored in hydrological respect regions.

And at last, more complete utilization of all available hydrological information using the modern methods of its processing and scientific generalization, also promoted raising the accuracy of maps under construction.

On the basis of the maps of fundamental water balance elements there are constructed such derivative maps as the

runoff coefficients maps, characterizing the correlation of income and expenditure parts of water balance, and the maps of excess and deficiency of the river water resources, representing the distribution of the regions with different water supply on the surface of the land.

The index of water supply is the difference between the runoff volume and moisture deficit determined as the difference between evapotranspiration and evaporation.

The maps of intrayear basic water balance elements-distribution describing by means of diagrams the types of intrayear precipitation distribution and river regime of different regions of the globe, are constructed and placed in the Atlas. The diagrams of precipitation distribution are placed in accordance with the meteorological stations location, and the diagrams of runoff distribution (hydrographs) are shown at the center of river spillways except for big rivers, the runoff distribution of which is represented by hydrographs in the alignments of hydrological stations.

Isolines were used as major means of presenting hydro-meteorological information on maps: to depict quantitative characteristics of annual values of water balance components and their spacial prevalence, while diagrams were used to describe interannual distribution of these values.

The Atlas is made in several colours (from 4 to 6) which have been chosen according to the traditional publishing of hydrological maps and to the nature of elements and phenomena presented.

Maps of the Atlas are placed in a special file. Such an arrangement is suitable for a combined chart analysis when overlapping is used and for compilation of derivative maps.

The Atlas of World Water Balance, according to the opinion of Soviet and foreign scientists, is a significant achievement in hydrology and, in particular, in hydrolo-

gical mapping. It sums up the studies on water balance, as well as theoretical basis and techniques of hydrological small-scale mapping at the present stage of development. It is also an essential contribution of Soviet scientists in the IHD.

Unlike earlier map-making of water balance, the above Atlas is remarkable for its completeness and reliability.

The Atlas reveals distribution regularities and gives a visual presentation of qualitative and quantitative characteristics of different components of water balance on the Earth's surface.

An analysis of the maps in the Atlas has promoted specification of the amount of precipitation at the Earth, total volume of streamflow in the area of its formation, evaporation and water supply of various regions of the globe.

The Atlas of water balance has importance beyond the new data obtained on water balance components. It reflects the positive experience of joint efforts of some institutions of the USSR Hydrometeorological Service and wide international cooperation in solving one of major global problems: the investigation of water balance and water resources of the Earth, and its rational use and security.

This cooperation may be rather effective because many rivers and other water bodies have boundaries other than State frontiers, they are usually investigated and used by several countries.

The Atlas may be of importance for regions lacking hydrometeorological data, in particular, for developing countries.

According to the UNESCO resolution, the Atlas of water balance of the Earth is published in English, so that hydrologists of all countries will get acquainted with the Atlas and make use of it. (The English version of the publication is provided with extensive explanatory notes concerning the Atlas).

The experience accumulated on compiling and publishing the hydrometeorological maps, as well as the Atlas itself, will contribute to a further development of theoretical and applied problems of hydrological and meteorological map-making and compilation of complex atlases made on a larger scale, the latter presenting the most dynamic hydrometeorological elements of geographical landscape and their intricate interaction in nature.