weapons; tents and boats of various kinds, special instruments and apparatus for polar expeditions, &c., not to mention narratives and publications of every kind relating to voyages.

How varied the programme of this exhibition is will be seen from the above, as well as the fact that the geography of the present day is a very complicated and all-embracing province of knowledge indeed.

It is impossible here to analyse in detail the exhibits of each country; we can only at present refer to some of the objects which, as we learn from a correspondent, have attracted considerable attention.

The fine set of instruments for travellers exhibited by our Royal Geographical Society, and invented by Capt. Georges, R.N., seems to have excited considerable attention; it includes a double pocket sextant, an artificial horizon, and a barometer; the latter especially, on account of its ingenious construction, making it useful in mountaineering, is said to have attracted the attention of the New French Alpine Club.

From Norway comes a very simple declimeter having a crank working on a small notched wheel which multiplies by ten the number of degrees on the limb on which the readings are taken; a close approximation can thus be obtained by a very simple contrivance.

A Russian marine officer has sent a compass magnificently fitted up, and a lead for taking soundings, and samples of the bottom in lakes and shallow seas. It was used with success on Ladoga, the Caspian, and the Baltic. The apparatus is very simple, cheap, and not ponderous.

Mohn's map of churches struck by lightning in Norway is exhibited in order to illustrate the special danger of lightning to churches. It shows that two churches in every three years are struck and one of the two is utterly destroyed, and that in a climate where thunderstorms are relatively infrequent.

Sweden exhibits two wonderful pieces of apparatus. The first is a meteorograph for printing in numbers the degrees of dry and wet bulb thermometer, barometer, and the force of the wind. The types are placed on wheels which are moved every quarter of an hour by electricity. The barometer is a syphon one, and the thermometers open by the top a needle which descends every quarter of an hour into the mercury and gives the degree. The apparatus works regularly at the University of Upsal and at the Vienna Observatory, where the readings have been found quite correct. The printed sheets obtained at Upsal are posted on the wall of the Geographical Exhibition.

A Swedish engineer has invented a machine to show where to find beds of iron ore, and to determine also the depth to which it is necessary to descend. The miracle is performed by tracing on a map isodynamic magnetic curves, with a compass exposed to the perturbating influence of a magnetic needle placed at a distance. Two systems of isodynamic curves are to be traced, and the distance between both centres is proved to indicate the depth. Experiments and explorations with this extraordinary instrument have proved successful.

The Belgian universal meteorograph, as used in Ghent, is said to be the great success of the Exhibition. It is expected to create a revolution in weather-warnings and in meteorology generally, and will leave the famous Greenwich registering apparatus far behind. A reading is taken every quarter of an hour and engraved on copper ready for going through the press. The inventor is M. Van Rysselberghe, Professor to the Navigation School of Ostend.

The members of the several juries visited the galleries of the Exhibition on Monday last for the first time. Many members of the Academy of Science—MM. Leverrier, Faye, Quatrefages, and others—were present, as well as the foreign commissioners. We hope to give further details next week.

THE REGULATION OF RIVERS

THE recent disastrous floods in France and England call attention to the question whether it is practicable so to regulate the flow of the water in rivers as to prevent, or at least greatly diminish, such misfortunes for the future. Facts and numerical data exist which show that such regulation is practicable with much less difficulty and cost than would be thought by any one who had not made the necessary calculations.

It is perhaps scarcely necessary to say that the method of keeping the floods off the lands by means of embankments, which is the only possible resource when we have to contend against the sea or tidal rivers, is totally inapplicable to the case of the inundations of mountain streams like the Garonne. There need not be any difficulty as to the strength of the embankments, but it would be impracticable to make them high enough to contain between them such torrents as that of the Garonne when in flood. The only way in which mountain torrents can be regulated is by constructing reservoirs to retain the flood-water: and the more this plan is looked at, the more feasible it will appear.

We shall first refer to a paper by Charles Ellett, jun., C.E., on "the Physical Geography of the Mississippi Valley, with suggestions for the improvement of the navigation of the Ohio and other Rivers," forming part of the "Smithsonian Contributions to knowledge" for 1851, published by the Smithsonian Institution, Washington.

This paper contains the tabulated results of an elaborate series of observations made by the author in the spring and summer of 1849 on the flow of the Ohio, at Wheeling, between Pittsburg and Cincinnati. The flow varied from 10,158,000 cubic feet per hour, with a depth of 2.20 feet on the bar at Wheeling, to 736,000,000 cubic feet, with a depth of 31·25 feet on the bar.

"The average volume of water annually flowing down the Ohio is 835,000,000,000 (eight hundred and thirty-five thousand million) cubic feet. This volume would fill a lake 100 feet deep and $17\frac{1}{3}$ miles square. To have regulated the supply of the river in 1848, so as to have kept the depth on the bar at Wheeling uniform throughout the year, would have required reservoirs capable of holding 240,000,000,000 cubic feet, which is equivalent to a single lake 100 feet deep, and $9\frac{1}{8}$ miles square. There is no difficulty, on any of the principal tributaries of the upper Ohio, in obtaining reservoirs capable of holding from twelve to twenty thousand millions of cubic feet. It can scarcely be doubted that twelve or fifteen sites for dams may be selected capacious enough to hold all the excess of water, and equalise the annual discharge so nearly that the depth may be kept within a very few feet of an invariable height."

To control the floods of the river, however, much less than this would be needed. Mr. Ellett takes the case of the flood of March 1841, as being that in which the greatest quantity of water passed down of all the floods concerning which he has information. He takes 25 feet of depth on the bar as the high-water mark, above which the river is in flood; he estimates that during nine days of flood the river passed down 159,000,000,000 cubic feet of water, while during the same time, had it been steady at the high-water mark, the discharge would have been only 115,000,000,000. If consequently the excess of 44,000,000,000 had been kept back in reservoirs, the flood would have been prevented.

The volume it is here proposed to deal with—44,000,000,000 cubic feet—is "just equal to the quantity the river would discharge in fifty days when there is a depth of five feet in the channel."

The valley of the upper Alleghany, one of the tributaries of the Ohio, is about a third of a mile in width. A dam from 55 to 60 feet in height, thrown across the trough of this valley, so as to submerge not only the main

valley but its branches, would, according to Mr. Ellett, "probably form a lake covering from 16 to 18 square miles, with an average depth of nearly 30 feet, and containing more than 12,000,000,000 cubic feet of water." "It follows then that we should need but four dams, such as we have described, to secure the valley of the Upper Ohio against all destructive floods.

This however assumes that at the beginning of a flood the reservoirs will be empty—a condition on which it would not be safe to rely. It also seems that the shape of the valleys of the tributaries of the Ohio is everything that could be wished by an engineer who desired to convert them by means of dams into artificial lakes. They are trough-shaped, moderately wide, long, and not too steep. This last is a great advantage, because the steeper the valley the shorter is the lake that will be formed by a dam across it. It is likely that the Garonne and its tributaries are less favourably circumstanced, but nevertheless in a country of such varied contour as the south-west of France, there must be many eligible sites for reservoirs. In another way also the Garonne will certainly be found a less manageable river than the Ohio, namely that the volume of its floods bears a much higher ratio to its ordinary flow.

After the disastrous floods of the Loire in 1855, the late Emperor wrote a letter to his Minister of Public Works recommending the control of the floods by means of a number of small reservoirs to be formed by building dams across the mountain valleys. This however was lost sight of, and we see the result in the ruins of Toulouse.

A most useful work of this kind has been in operation for many years in Ireland. The following particulars are taken from a paper "on the Industrial Uses of the Upper Bann River," by John Smyth, jun., C.E., read at the Belfast Meeting of the British Association last year, and ordered by the General Committee to be printed *in extenso*.

The purpose of the reservoirs on the Bann is not to prevent floods, which, so far as we are aware, were never particularly disastrous on that river, but to equalise the flow of the river for water-power. "In 1835 the principal mill-owners formed themselves into a provisional committee to take steps to procure a better and more regular supply of water by the construction of reservoirs. They placed the matter in the hands of Sir William Fairbairn, who, assisted by J. F. Bateman, Esq., surveyed the collecting grounds of the river Bann and its several tributaries." Under their advice two reservoirs were constructed at Lough Island Reavy and Corbet Lough.

The Lough Island Reavy reservoir is 250 acres in extent, and contains 270,000,000 cubic feet. It cost 15,000*l.* to construct, besides 6,000*l.* for land. It is 430 feet above the sea-level, and is supplied by two mountain-streams. Its drainage area, including the lake itself, is only about five square miles, and it is filled and emptied only once in the year.

The Corbet reservoir is lower down than the other, and is chiefly filled from the Bann itself. Its extent is 70 acres, and its capacity 28,000,000 cubic feet. It "has been of much more service than its capacity would lead one to expect, as it may be filled and emptied four or five times in each year by small floods in the river, and all the Sunday water can be sent into it, and let down to the mills on Monday and Tuesday. It is generally exhausted before the upper reservoir is called on, and keeps up a supply when there is a scarcity in frosty weather."

The purpose of regulating the supply has been tolerably well attained. "A register of the daily height of the water in Lough Island Reavy has been kept since 1847. It shows that this reservoir has been of great service, as during 26 years an average supplementary supply of about two-fifths of the standard summer discharge allowed over Ervin's Weir, or about 30 cubic feet per second, has been granted, for, on an average, 102 days yearly: and the reservoir has been empty, on an average, eleven and a half days yearly." "The register of the Corbet reservoir has not been kept so long or so accurately as that of Lough Island Reavy; from the average of three years, however, and comparison with the register of Lough Island Reavy, I calculate it has given 120,000,000 cubic feet in the year, exactly one half that of Lough Island Reavy, or a good supply for fifty-one days; add to this the Lough Island Reavy supply, and there is a total of 153 days of twenty-four hours each." "As the supply from the reservoirs has only failed, on an average, eleven and a half days yearly, the standard water power may be said to have been almost constantly maintained:—indeed it is almost as good as steam-power, but at much less cost."

The income of the Company which has made the reservoirs is derived from a charge authorised by their Act of Parliament of 10*l.* per annum per foot of fall occupied by manufactories, and half of this when occupied by flax scutching mills and country corn-mills. The total fall from the upper reservoir to the bottom of the lowest fall is 350 feet, of which 180 are occupied by machinery. The capital of the Company is 31,000*l.*, and the dividend about three per cent., with a certainty of increase, if the advance in the price of coals, and the expected opening of the higher part of the district by railway, lead to more of the falls being occupied.

We think the calculations we have quoted from the American engineer, and the example of what has been done on a comparatively small scale in Ireland, are enough to show that the most difficult problems of the regulation of the flow of rivers may be approached with great hope of success.

*THE GIGANTIC LAND TORTOISES OF THE MASCARENE AND GALAPAGOS ISLANDS**

II.

ALTHOUGH the island of Aldabra is a British possession, its distance from the Mauritius and the Seychelles renders a supervision on the part of the Government very difficult, and no control whatever can be exercised on crews of ships who land there chiefly for the purpose of cutting wood, which they require for curing fish, &c. Information having reached England in the course of last year that it was intended to lodge permanently wood-cutting parties on the island, the speedy extinction of the tortoises seemed imminent; and the time to prevent this seemed all the more opportune, as the then Governor of the Mauritius, Sir Arthur Gordon, was known to take great interest in all matters relating to natural history. Consequently the following memorial was addressed to him, signed by the presidents of the Royal and Royal Geographical Societies, and other men of science who had made researches into the extinct fauna of these islands:—

To His Excellency the Hon. Sir Arthur Hamilton Gordon, K.C.M.G., Governor and Commander-in-Chief of Mauritius and its dependencies.

We, the undersigned, respectfully beg to call the attention of the Colonial Government of Mauritius to the imminent extermination of the Gigantic Land Tortoises of the Mascarenes, commonly called "Indian Tortoises."

2. These animals were formerly abundant in the Mauritius, Réunion, Rodriguez, and perhaps other islands of the western part of the Indian Ocean. Being highly esteemed as food, easy of capture and transport, they formed for many years a staple supply to ships touching at those islands for refreshment.

* The substance of this article is contained in a paper read by the author before the Royal Society in June, 1874, which will appear in the forthcoming volume of the "Philosophical Transactions," and to which I must refer for the scientific portion and other details. Some facts which have come to my knowledge subsequently to the reading of this paper, are added. Continued from p. 239.