ART. II.—*Influence of Forests on Climate and Rainfall.* By FREDERICK S. PEPPERCORNE, Civil Engineer.

[*Read before the Hawke's Bay Philosophical Institute, 14th July*, 1879.]

No fact is better authenticated than that of the beneficial influence exerted by the presence of forests on the climate and rainfall of a country, and, on the other hand, of the injurious effects on both that is brought about by the destruction of forests, or by their absence.

In this way their destruction has often become a real calamity to a country, and has proved to be one of those errors which nothing can excuse, and which nothing but a resort to years of tree-planting, in order to replace the forests destroyed, can remedy. That this is not an exaggerated view to take of the subject, is shown when we know the evil effects produced in many countries by the denudation of their forests—one striking instance of which is to be found in Spain, the central regions of which, comprising the Castiles, part of Leon, Estremadura, and La Mancha, possess at present an execrable climate, although, in the times of the Roman occupation of Spain, these districts were noted for the fertility of their soil and for the amenity of their climate, so that the words, "*Nihil otiosum, nihil sterile in Hispania,*" passed into a proverb. But, at present, as we are told by Sir A. Ford, "The denuded table-lands are exposed to the fierce suns of the summer and to the fiercer snows and winds of winter, while the bulk of the peninsula offers a picture of neglect and desolation, moral and physical, which it is painful to contemplate. Extensive steppes and plains are burnt up by the sun in summer, and swept by the icy winds in winter, while rain is so rare in the table-lands that the annual fall does not exceed nine inches, and there are districts upon which no shower descends for eight or nine months together. The face of the earth is tanned tawny, and baked into a veritable '*Terra-cotta,*' and everything seems dead and burnt, as on a funeral pile."

And yet, under the dominion of the Moors, the country blossomed like a rose, while now Spain is one of the droughtiest and poorest countries in Europe, and the ignorance and prejudices of the peasantry have completed the devastation of her forests which her Catholic monarchs commenced. Fortunately, however, for Spain, she now possesses some enlightened men who, having been able to trace the causes of the evil up to their true source, are setting to work to remedy it, and are impressing upon the Spanish Government the imperative necessity of replanting the mountain ranges as the only efficient method of combatting the drought and its attendant disasters. They show clearly that the demolition of the forests has operated most disastrously both upon the soil and climate; that springs and streams have dried up; that rain has ceased to fall at one period of the year when it is most wanted, and descends with great violence at other times. This

causes the surface-soil to be washed off the hills (which have been denuded of their timber) and carried into the valleys, from whence it is swept away by calamitous inundations into the sea.

The preservation of the forests of a country is, therefore, one of the first duties of an enlightened Government; for, as Professor Macarel, a French writer of some note, observes: "All the wants of life are closely related to their conservation: agriculture, architecture, and almost all the industries, seek therein their aliment and resources, which nothing can replace. Necessary as are the forests to the individual, they are not less so to the State; their existence is, of itself, of incalculable benefit to the countries that possess them, as well in the protection and feeding of the springs and rivers, as in their prevention against the washing away of the soil upon mountains, and in the beneficial and healthy influence which they exert upon the atmosphere. Large forests deaden and break the force of heavy winds that beat out the seeds and injure the growth of plants; they form reservoirs of moisture; they shelter the soil of the fields and upon hill-sides, where the rain-water, checked in its descent by the thousand obstacles they present by their roots and by the trunks of trees, has time to filter into the soil, and only finds its way by slow degrees to the rivers. They regulate, in a certain degree, the flow of the waters and the hygrometrical condition of the atmosphere, and their destruction accordingly increases the duration of droughts and gives rise to the injuries of inundations."

The truth of these observations admits of no doubt, and instances may be multiplied to prove their accuracy. Thus, the island of Cyprus was, in ancient times, famed for its fertility when its hills were covered with timber; but of late years, and since the denudation of her forests, the bare and thirsty soil seems, as it were, to repel the rain-bearing clouds, and the island has become the prey of periodic drought and disease. During the three consecutive years from 1859 to 1861, no rain fell at Cyprus, and the inhabitants migrated *en masse* to the adjacent shores of Syria. Malaria appears to have become chronic in the island; but since its recent occupation by the British, an extensive system of tree-planting has been commenced under the auspices of Sir Garnet Wolseley, who, in a recent letter to the First Lord of the Admiralty, writes: "I am now planting 20,000 *Eucalyptus* trees of one and two years' growth, and even supposing that one-half of these die, I shall have made a good start towards replenishing the island with timber."*

* All who have made themselves acquainted with the French colonization of Algeria, must admire the public spirit displayed during the last twenty years in respect to the "*reboisement*," or re-timbering of the country, chiefly with the *Eucalyptus globulus* and other varieties of this tree—a measure which has been found to be equally effective both on sanitary and economic grounds.

Again, the Island of St. Helena offers a striking example of the effects of forest denudation upon its climate and rainfall. When it was first discovered in 1502, the island was covered with timber, which in many instances came down to the water's edge, and innumerable rivulets heightened the verdure of the land. But, shortly after its colonization, the inhabitants went recklessly to work to destroy the trees, and this was followed by a succession of severe and destructive droughts; so that, all through the 18th century, there were almost periodical visitations of these scourges, occasioning ruinous losses of cattle and crops. The East India Company, however, having adopted energetic measures for the replanting of the island with the cluster pine and other hardy forest trees, the result has been that the annual rainfall has become equal to that of England, and that it is spread almost evenly over the year, while droughts are altogether unknown.

Similar effects have been recorded with respect to the Island of Mauritius, in which a steady diminution of the rainfall has taken place since the destruction of no less than 70,000 acres of forests, or about one-sixth of the entire area of the island. This work of destruction was accomplished in the ten years from 1852 to 1862, with the following results as reported by Mr. Meldrum, the Director of the Observatory at that island:—"*In no former* year of the period of fourteen years did such floods occur as in 1861 and 1866, or such severe droughts as in 1865 and 1866. Nor is this all; for the Mauritius, which was formerly a 'sanatorium' for British officers invalided in India, is subject to deadly epidemics, owing to the lowering of some lakes and the complete desiccation of others. *Malaria has thus* been generated, and cholera and fevers have followed. Latterly, however, an extensive system of tree-planting has been commenced, with the best results."

On this subject also, Dr. Hooker, in a letter to Lord Kimberley, who was at that time Secretary of State for the Colonies, wrote as follows:—"The mischief already done in Mauritius and various West Indian islands is so widely spread (being in some, indeed, irreparable), and the feeling of the colonists against any interference on the part of the Government is apt to be so determined, that I venture to press upon your lordship my own opinion as to the urgency of active steps being taken in the case of an island so beautiful, and at present so fertile, as Ceylon. I have lately received an account of the deterioration of the climate of some of the Leeward Islands, which affords a melancholy confirmation of what I have urged above. The contrast between neighbouring islands similarly situated is most striking, while the sad change which has befallen the smaller ones is, *without any doubt*, to be ascribed to human agency alone. It is recorded of these, that

in former times they were clothed with dense forests, and their oldest inhabitants remembered when the rains were abundant, and the hills and all uncultivated places were shaded by extensive groves. *The removal of the trees was certainly the cause of the evil.* The opening of the soil to the vertical sun rapidly dries up the moisture, and prevents the rain from sinking to the roots of plants. The rainy seasons in these climates are not continuous cloudy days, but successions of sudden showers, with the sun shining hot in the intervals. Without shade upon the surface the water is rapidly exhaled, and springs and streams diminish."

The opinion of so eminent a botanist as Dr. Hooker must be conclusive on this subject; and in the Report of the United States' Commissioner of Agriculture for 1871, there occurs the following passage:—"In Upper Egypt, the rains which, eighty years ago, were abundant, have ceased since the Arabs cut down the trees along the valley of the Nile towards Lybia and Arabia. A contrary effect has been produced in Lower Egypt from the extensive planting of trees by the Pasha. In Alexandria and Cairo, where rain was formerly a great rarity, it has, since that period, become more frequent."

Again, speaking of the State of New York, and of the lofty mountains amongst which its principal rivers take their rise, Professor Marsh says:—"Nature threw up those mountains, and clothed them with lofty woods, in order that they might serve as a reservoir to supply with perennial waters the thousand rivers and rills that are fed by the rains and the snows of the 'Adirondacks,' and as a screen for the fertile plains of the central counties, against the chilling blasts of the north wind, which meet no other barrier in their sweep from the Arctic Pole. The climate of Northern New York even now presents greater extremes of temperature than that of Southern France. During what is called the 'heated term,' the weather is almost tropical, and the deaths from sunstroke, even in the city of New York, which lies at the most southerly point of the State, may be reckoned by scores, while the winters have become of late years quite Siberian in their severity."

With regard to the felling of the Adirondack woods, and the effects thereof, Professor Marsh warns his countrymen that their destruction will render a wide-spread desolation inevitable, and he dwells on this point, because we are apt to think that America possesses exhaustless forests:—"Already (he says) the rivers which rise in that region flow with diminished currents in dry seasons, and with augmented volumes of water after heavy rains. They bring down larger quantities of sediment; and the increasing obstructions to the navigation of the Hudson, which are extending themselves down the channel in proportion as the fields are encroaching on the

forests, give good reason for the fear of irreparable injury to the commerce of the important towns on the upper waters of that river, unless measures are taken to prevent the expansion of 'improvements' which have already been carried beyond the limits of a wise economy."

In our vast Indian Empire, the Government, until quite recently, permitted a wholesale destruction of the forests, but has now begun to open its eyes to the disastrous effects produced, and has appointed forest conservators, whose duties are to see that the trees cut down are replaced by others, as the consequences of the reckless destruction of the Indian forests by demands for railroad and other uses, have already made themselves felt by the greater frequency of seasons of drought and famine, with all their attendant miseries; and with such data as are accessible in late reports, it cannot be doubted that these calamities are chiefly due to the denudation of the forests.

It is believed, however, that with a general scheme of forest conservation, by which the annual growth might be made to balance, as near as may be, the annual consumption, these evils would be greatly mitigated, if not removed entirely.

During the last half-century, great attention has been paid, both in France and Germany, to the art of "Forestry"—an art which comprises an extensive range of knowledge of various sciences, amongst which botany, chemistry, geology, and vegetable physiology, take the first rank. The area of the French State forests is put down at 3,130,000 acres, to which may be added 5,350,000 acres belonging to "Communes," corporations, hospitals, and other public establishments, and the whole of these forests are under the management of the French administration of Forests. In the "Vosges" the destruction had gone so far that the humidity had diminished, while the soil had become more arid and inundations more frequent. In the Department of the "Gard" it did not rain in 1837 for more than nine months, and the supply from wells was most seriously diminished. At "Berjiers" it was reported that the vast forest, which once sheltered that place, having been destroyed, the loss of the olive crop was the immediate consequence. Violent storms and torrents of rain certainly fell from time to time, but these did more harm than good, as the water ran off the land without penetrating into it. Such has been the result, in France, of the destruction of a great extent of her forests; but the regulations at present in force for their conservation and "*reboisement*" are of the most stringent nature.

In Prussia proper, out of 35,000,000 of "hectares,"* 8,000,000 are classed as forests, out of which nearly 4,000,000 are private forests; in

* A "hectare" is equal to about 2½ English acres.

both cases the regulations for their management and conservation are of the most comprehensive description.

In Switzerland, the question has become of such national importance that it has been proposed to modify the constitution so as to enable the Federal Government to undertake duties which have hitherto been performed by the several cantons.

In Austria, the management of forests has recently been transferred from the Minister of Finance to a distinct department, presided over by the Minister of Agriculture.

In India, the forest question is now being regarded as one of the first importance, and is being dealt with, not by the several Presidencies, but by the General Government on behalf of the country at large.

In Canada, there has been a certain amount of legislation on this subject; but in Sweden and Norway the most rigorous measures have been devised to protect the forests, and there are regulations to prevent trees under a certain age and size from being cut even by private owners.

Now, if in countries like France, Germany, Sweden, and Norway, whose forest lands are extensive, it has been found necessary to initiate and carry out a most careful system of forest conservation, how much more so must it be necessary in the dry and sultry climate of Australia!

In the colonies of Victoria and New South Wales, the evils produced by the gradual diminution of their forests, as well as by their destruction in dry seasons by bush fires, have now become apparent, and have combined to render the climate, which is naturally dry, year by year more dry, while but little has been as yet attempted for their preservation.

The consequences must inevitably be of the most serious nature, unless immediate steps are taken to conserve large tracts of the existing forests, as well as to initiate a well-devised system of tree-planting on the bare hills which have been denuded of their forests. Should this not be done, the inevitable result will be severe droughts of long duration, occurring more frequently than at present, to the great detriment of the pastoral and agricultural interests of these colonies.

In South Australia, the subject has, however, received much attention of late, and proposals have been made by Mr. Goyder, the Surveyor-General of that colony, to initiate a systematic course of tree-planting on a large scale. Mr. Goyder proposes to reserve 200,000 acres of land, and to spend on it, in tree-planting and management, £14,000 during the first year, and £10,500 during each of the following eleven years; thus making a total expenditure of £130,000, when the whole of the 200,000 acres would be planted and fenced in. During the first five years there would not be any revenue, but during the sixth, seventh, eighth, and ninth years, the revenue

from periodical thinnings was estimated at £35,000 annually, until the end of the twenty-first year, when the colony would be in possession of 300 square miles of forest.

These estimates may possibly be a little overdrawn, but the scheme appears well worthy of consideration, and it is to be borne in mind that in no case is natural forest or "bush" so valuable, commercially speaking, as planted forest, and no one can deny the fact that tree-planting, on an extensive scale, would be a very necessary proceeding in all the Australasian colonies wherever the natural forests have been largely destroyed, to say nothing of the undoubted beneficial influence it would exert upon the climate and rainfall.

Humboldt thought that dense woods gave out what he called a "frigoric," or cooling radiation, which condensed the vaporous clouds, so that there should naturally be frequent and abundant rains in their vicinity; and, on the other hand, he thought that the warm radiations which take place from level, sandy, and treeless plains, would produce little if any rainfall, and all our experience tends to show that these views are correct.

The foregoing examples have been selected from a mass of facts illustrative of the dependence, to a large extent, of the rainfall of a country upon the preservation or renewal of its forests, whether on mountain-ranges or on table-lands, or on less elevated tracts of country. And although the meteorological action of forests is but imperfectly understood at present, yet the data hitherto collected are quite sufficient to point to the conclusion that trees, being natural conductors of electricity, as has been proved by the experiments of M. Grandeau, Professor of the "*Ecole Forestrière*," in France, serve as intermediaries for the exchange of the electricities with which the earth and the atmosphere are respectively charged.

It has also been said that the earthquakes which are common in Spain and Portugal, would be less frequent and less violent if the elevated regions of those countries were clothed with forests, so as to secure regular and harmless conduction of the electric fluid from the aerial to the terrestrial reservoir, and *vice versâ*. However this may be, one thing is very certain, which is that hailstorms, which are believed to be produced by a certain specific electric action, become more frequent and destructive in districts which possess no forests; and on this point Signor Calvi, in his "Hints on the Importance and Cultivation of Forests," states that:—"When the chains of the Alps and the Apennines had not yet been stripped of their magnificent crown of woods, the May hail, which now desolates the fertile plains of Lombardy, was much less frequent; but, since the prostration of the forest, these tempests are laying waste even the mountain soils, whose older inhabitants scarcely knew the plague."

Enough has now been said to show the calamitous consequences of denuding a country of its woods and forests, and to show that writers of repute, who have made this subject their special study, are unanimous in connecting the occurrence of droughts and famines, the drying up of lakes and rivers, together with the outbreak of certain malarious epidemics, with the reckless destruction and waste of forests.

We are, in Australia and New Zealand, much in the same position as the inhabitants of India in this respect, and we are only beginning to feel the effects of the wholesale destruction of our forests. In New Zealand *particularly, the forest question is a vital one, and the sooner it is grappled with the better it will be for the colony,* the question being one which will so greatly influence its future prosperity, together with its commercial value as a colony, its climate, and its salubrity.

In a very interesting paper by Dr. Hector, showing the percentage of our forest land to the whole area of the colony, his estimate is, that between the years 1830 and 1868 the destruction of forests was as follows:—

In the Province of	Auckland	58 per cent.
,,	Taranaki	10 ,,
,,	Wellington	20 ,,
,,	Hawke's Bay	60 ,,
,,	Nelson	16 ,,
,,	Canterbury	10 ,,
,,	Marlborough	12 ,,
,,	Westland	5 ,,
,,	Otago	12 ,,

Showing that the average destruction during these thirty-eight years was about 25 per cent. During the five years from 1868 to 1873, it was estimated that of what remained in 1868, the following was destroyed:—

In the Province of	Auckland	27 per cent.
,,	Taranaki	11 ,,
,,	Wellington	25 ,,
,,	Hawke's Bay	30 ,,
,,	Nelson	20 ,,
,,	Marlborough	28 ,,
,,	Canterbury	33 ,,
,,	Westland	21 ,,
,,	Otago	10 ,,

In other words, taking the whole colony, 20 per cent. of what forest remained in 1868 had been destroyed during the five years ending in 1873!

It will be observed that in these estimates the Province of Hawke's Bay stands pre-eminent in its "bad eminence" for destructiveness of forests, which, if it continues in the same ratio, will leave it with very little, if any, standing timber in the year 1899, or in twenty years hence.

Dr. Hochstetter, in his valuable work on the geology and natural history of New Zealand, pointed out the fact that extensive districts which had formerly been covered with forests of kauri pine were, when he wrote, totally destitute of this most valuable of the forest trees, and that its extermination was progressing from year to year at such an alarming rate, that its final extinction was as certain as that of the natives themselves, only in a much shorter period of time.

Such being the facts of the case, it is surely necessary that some steps be taken to preserve a portion of our forests, and to check the continually increasing destruction which is still being carried on; and it would appear to be not only expedient but absolutely necessary that the far-seeing views which were expressed on this subject by Sir Julius Vogel, in 1874, and which were—to create a department of "Woods and Forests," and to enact forest laws, be carried out without delay.

The most stringent measures will now have to be resorted to for their conservation; a sum of money should be set apart annually for the purpose of planting and improving the State forests; every township in the colony should have its adjacent forest reserve; and every encouragement should be given to landowners towards the planting of trees on their farms and runs.

Should this not be done, after the fashion of other and older countries, and should no steps be taken to conserve our forests, the consequences will, in all probability, be of the most disastrous nature to the ensuing generation.

Art. III.—*Notes on Port Nicholson and the Natives in* 1839.

By Major Charles Heaphy, V.C.

[*Read before the Wellington Philosophical Society, 11th October*, 1879.]

Having been in Port Nicholson before the arrival of the settlers, I have put together the following notes on the physical aspect of the place, and the condition of the native inhabitants at that time.

In September, 1839, when I arrived here in the 'Tory,' with the expedition to select a fitting site for the New Zealand Company's first settlement, no ship had been in the harbour for a considerable time, probably three or four years. The place lay out of the track of whaling ships, and there was but little flax-trading to be done at it. Large, and for a time prosperous, whaling-stations existed at Port Underwood, Tory Channel, and Kapiti. The tide running past the heads on into those harbours, whale-ships lay at anchor there, with their boats in readiness, and nume-