

probably disclose a vaster mortality, 'when the sea shall give up her dead,' than all that have perished by earthquake and its effects." (*Report, B.A.*, 1850, p. 63.)

There is, however, one consideration which ought not to be forgotten—that however man may be affected by these accidental events, as this writer calls them, the earthquake "will ever maintain its supremacy over all phenomena and circumstances, for it is out of the power of man to foresee, to provide for, or to counteract its effects;"—and if nothing else can teach the same lesson, he may therein be able to see his utter powerlessness and insignificance amidst the wonders of that creation in which he holds dominion over all the other works of the Creator.

As Humboldt has well said, we may flee from the crater of a volcano in eruption; or even from a lava stream that threatens to invade our dwelling; but "in an earthquake, direct our flight whithersoever we will, we still feel we tread upon the very focus of destruction." We lose our faith in the idea of stability and practically acknowledge that no figurative language can convey so grand a notion of the glorious majesty of God, as that which an ancient prophet uses in describing the terrors of man, "when He ariseth to shake terribly the earth."

ART. V.—*On the Water Supply of Sydney, by Professor Smith.*

[Read 14th October, 1868.]

IT is my intention to give in this paper a brief account of the manner in which Sydney has hitherto been supplied with water, reserving for some future occasion the question of the improvement and extension of the supply.

The first fleet sent out from Great Britain to found the colony of New South Wales, arrived, as you may be aware, in Botany Bay on the 18th, 19th, and 20th January, 1788. Being disappointed with the capabilities of that locality, "which," says Mr. White, the surgeon-general of the expedition, "does not in my opinion by any means merit the commendations bestowed on it by the much-lamented Cook, and others whose names and judgment are no less admired and esteemed," the Governor (Phillip) and a small party went round to ascertain if nothing better could be found in Port Jackson. "The different coves of this harbour," we are told in 'Phillip's Voyage to Botany Bay,' published in

1789, "were examined with all possible expedition, and the preference was given to one which had the finest spring of water. This cove is about half a mile in length, and a quarter of a mile across at the entrance. In honour of Lord Sydney, the Governor distinguished it by the name of Sydney Cove." In "Collins's New South Wales," published in 1798, it is said that "the spot chosen [for the settlement] was at the head of the cove, near the run of fresh water which stole silently along through a very thick wood, the stillness of which had then for the first time since the creation been interrupted by the rude sound of the labourer's axe, and the downfall of its ancient inhabitants." In this judiciously selected spot, abounding in natural beauty, and possessing many of the features (though by no means all) that ought to mark the site of a great city, the fleet was brought from Botany Bay on the 26th of January. The whole of the people were landed by the 6th of February, and were found to number 1030. Thus was planted the germ, not, it must be allowed, a healthy or promising one, but still not devoid of irrepressible British vigour, which through many vicissitudes and varying fortunes has grown and expanded until in eighty years it has overspread a great portion of this island continent with nearly a million and a half of energetic, self-governing, English-speaking people. At the head of Sydney Cove, and on the banks of the clear running stream, the tents and huts of the infant settlement were erected. It was not long before the supply of water became a source of anxiety, for the stream was scanty, and doubtless sometimes stopped running, but we are told that the people soon began to dig wells, and were successful in finding springs.

By a notice in the *Sydney Gazette* of date October 19th, 1811, it appears that when the settlement was only in its second year, it fell into great straits for want of water. "From the best information we can collect," says the *Gazette*, "so intense a drought at this time of the year has not been witnessed since the year 1789, when the new colonists suffered a parching thirst for several months, the springs from which they had been before supplied either failing totally, or yielding scarcely a sufficiency to supply nature."

As the town increased, wells were multiplied, and the rivulets falling into other parts of the harbour were laid under contribution, particularly the copious stream running into Blackwattle Swamp; but for a number of years the Tank Stream was the main dependence, and strenuous efforts were made from time to time to husband the supply and preserve its purity. Three reservoirs or "tanks" were excavated in the rock near the mouth of the stream, close to the point where Hunter-street and Pitt-street now intersect. I have not discovered the exact date of

the construction of these tanks, but it must be at least as early as 1802, for a "General Order" was issued on the 14th October of that year, and republished in the *Sydney Gazette* of 18th December, 1803, of which the following is an extract:—"If any person whatever is detected in throwing any filth into the stream of fresh water, cleaning fish, washing, erecting pig-styes near it, or taking water up but at the Tanks, on conviction before a magistrate their houses will be taken down, and forfeit £5 for each offence to the Orphan Fund." It is further enjoined that the fences along the stream should be kept in good repair—that no person might have access to it but at the Tanks. Allusion is made to this fencing in the *Gazette* of 16th October, 1803:—"The enclosure of the Tank, undertaken by Government, will, when completed, considerably improve the town in its appearance, and render universal benefit in the preservation of its excellent stream. Every appearance of rubbish has been removed from its sides, and the crystal current flows into the basin with its native purity."

In the "Government and General Orders" of date 15th September, 1810, I find the following:—"It having been represented to his Excellency the Governor, as a very serious grievance, that the Stream of Water which flows through the town of Sydney, and the Tanks which have been constructed thereon (at considerable expense), for the purpose of procuring an adequate supply of pure and good water for the necessary accommodation and benefit of the inhabitants at large, are frequently polluted, and rendered totally unfit for those valuable purposes (which become the more important by the scarcity of wholesome water with which the town is supplied); and it thence becoming an object of the first consideration to the health and comfort of all persons residing within the town of Sydney, that said stream and Tanks should be strictly preserved and guarded against all abuses whatever, his Excellency deems it necessary to issue the following Orders:—

"1. That no necessities, slaughter-houses, tanneries, dyeing-houses, breweries, or distilleries, shall be in future erected on or near to the said stream, tanks, or springs flowing thereto . . . and further that all . . . [such nuisances] already erected or established thereon, shall be immediately pulled down, or otherwise suppressed, under pain of the owners or possessors being proceeded against, and prosecuted under the Nuisance Act.

"2. That no person shall presume to throw any dirt, rubbish, ashes, dirty water, or filth of any kind into the tanks, or streams supplying them, or into any of the springs or streamlets flowing to and past the said tanks.

"3. That no linen, clothes, or any other article, shall be washed in the said tanks, stream, springs, or streamlets.

“4. That no pigs, goats, sheep, horned cattle, or horses, shall be permitted to drink at, or otherwise render foul, the said waters, or any part of them, under pain of forfeiture of said animals, as already prescribed in his Excellency’s public notice, dated 11th of August last.”

The next reference that I find to the Tanks, is in the *Sydney Gazette* of March 2nd, 1811. “The long prevailing drought has destroyed every hope of the maize crop, which is unfortunately past recovery. A scarcity of water has also been the consequence, scarcely ever before witnessed. In Sydney the Tanks have been several weeks empty, and those who were in want of water obliged to collect it from small cavities in the spring course above the tanks, which has afterwards been sold at from fourpence to sixpence per pail.” Heavy rains fell soon after the date of this notice; and for several years thereafter (with the exception of 1814-5), floods were more characteristic of the country than droughts. So frequent, indeed, were these floods, and so destructive, that fears were entertained that the cultivation of the alluvial flats of the Hawkesbury, on which Sydney then greatly depended, would have to be given up.

In 1820 there were two or three heavy bursts of rain, causing floods, but there was also a continuance of dry weather, which brought out the following notice in the *Gazette* of October 28th:—“The present dry season of the year being indicative of an approaching long drought, which will be much felt throughout the town of Sydney, we presume it would be advisable, as much for the sake of decency as cleanliness, to pay a little if not due regard to the general orders in existence relative to the preservation from all filth and impurity of that valuable and serviceable reservoir—the Tanks. With much pain we have lately observed individuals washing themselves in this stream of water, particularly in that part that runs central from King-street, because that spot is almost secluded from every eye, that of curiosity excepted. In former times the punishment for this offence, it may be recollected, was summarily severe;” and they go on to quote from the General Order of September 1810. In 1823 the *Gazette* (November 6,) again comes out in defence of the water supply, by a republication of the General Order of September, 1810, prefaced by the following words:—“In consequence of certain intelligence having reached us, to the serious injury and annoyance of the inhabitants of the town of Sydney, that the stream of water which flows through the town, and the tanks which have been constructed thereon, at a vast expense to Government, are systematically polluted and rendered totally unfit (if known generally) for the valuable purposes intended, we have thought it advisable to publish the following extract, &c.” A drought of some severity began in this year, and continued till towards the

end of 1824. In the *Gazette* of March 18th of the latter year we read :—"As we have had but little rain since July, water has been scarce in town ; but then it should be gratefully remembered what a providential supply Blackwattle Swamp furnishes in the most dry season. It would be well to build a reservoir or tanks at this spot The kindness of the Government will, it is humbly presumed, ever secure this spot from the clutches of private individuals." Of course the kindness of the Government did no such thing ; and, indeed, it would have been utterly impossible to preserve the purity of the streams that drain the area on which Sydney stands ; but had anything like the same care been bestowed on the waters that drain into the north side of Botany Bay as was fruitlessly lavished on the Tank Stream, Sydney might have been abundantly supplied at the present day. And yet, perhaps, it was a mere question of time, and it might have been no more possible to preserve permanently the drainage area of Shea's Creek (the chief of the Botany waters lost to the public) than it was to save from defilement the streams flowing into Darling Harbour and Sydney Cove.

The drought of 1823-4—we learn that 35 inches of rain fell in the former year, and only about 19 inches in the latter (*Gazette*, 10th March, 1825)—drew public attention more strongly than ever to the deficient supply of water ; and at the Quarter Sessions commencing on November 9th, 1825, the presentment of the Grand Jury contained the following passage.—“The Grand Jurors have to lament that their repeated presentments of the inadequate supply of Sydney with water have been hitherto disregarded. They have, therefore, again strongly to urge the indispensable necessity of some immediate measures on this subject. The principal stream whence the inhabitants are at present supplied with this necessary article they find still unclosed, and polluted by common sewers, and every description of filthy pools emptying themselves into it, which must render it of highly deleterious quality.” And at the Quarter Sessions, in February, 1826, the subject of the water supply is again brought forward in similar terms. The despairing attempts to preserve the Tank Stream, and the pathetic way in which the *Gazette* holds up its condition, have not a little of a comic element. “We actually beheld,” says the *Gazette* of 1st March, 1826, “upwards of half a dozen boys bathing in the very stream from which, it is most probable, the next moment many of the inhabitants of Sydney were obliged to supply themselves with water for culinary purposes.” These representations, equally with the authoritative orders of Government, were all in vain. Nothing could save the Tank Stream. Its inevitable destiny was to become a filthy sewer, and, in that capacity, it has long been covered over and hidden from public view. After 1826 I find no farther

reference to it as a source of water; and, indeed, if you consider its limited drainage area it is remarkable that it should have served Sydney so long. If a person start from the Custom-house, and proceed (by Bridge-street and Macquarie-street) to the middle of Hyde Park, then across to Bathurst-street, thence to George-street, and round by the Police-office to York-street, thence to Church-hill, and back to the Custom-house by Bridge-street, he will have enclosed (in a circuit of about two miles) the whole area drained by the Tank Stream, amounting to no more than 178 acres. Part of this area, however, was well fitted for the retention of water; for I have been informed by an old colonist that a spongy swamp once stretched from about the position of King-street back towards Park-street, and laterally towards George and Castlereagh streets,—such a swamp as may still be seen in several places near Sydney, giving rise to streams of a remarkably permanent character.

The year 1826 began with heavy rain and floods, but soon changed to a prolonged drought, which must have helped materially to bring the question of water supply to a crisis. This year, says Captain Sturt, commenced “one of those fearful droughts to which we have reason to believe the climate of New South Wales is periodically subject. It continued the two following years with unabated severity.” If we consider further that the population of Sydney now amounted to 10,000, it will be understood that a new and more abundant source of water was imperatively needed. In 1824, Mr. John Busby had arrived in the colony with the appointment of Mineral Surveyor to the Government, and his labours were soon turned by Sir Thomas Brisbane to a search for water. After examining several localities near Sydney, he ultimately reported (in 1826) in favour of the Lachlan Swamp, lying to the south-east of Sydney, in the hollow between Paddington and Randwick. Mr. Busby’s plan was adopted, and the work of driving a tunnel from Hyde Park to the Swamp was commenced in September, 1827. From the unmanageable and unskilful character of the labourers employed (convicts), and from unforeseen difficulties in the strata that had to be gone through, the undertaking was much more tedious and difficult than had been anticipated, and it was not till June, 1837, that it was brought to a successful termination. The tunnel, however, began to supply Sydney with water as early as 1830, by virtue of drainage from the surrounding rocks. The whole length of the tunnel is 12,000 feet, upwards of $2\frac{1}{4}$ miles—with an average width of four feet, and height five feet. Twenty-eight vertical shafts were sunk from the surface, varying in depth from twenty to eighty feet; the whole mass of excavation amounted to 255,930 cubic feet, fully nine-tenths being through solid rock; and the total cost was £24,000. The catchment basin of the

Lachlan Swamp is about two square miles, but probably only about half of that area actually drains into the tunnel; and as no provision is made for retaining storm-waters at the swamp, a great proportion of the rainfall runs down to Botany Bay. The tunnel remains in good order to the present day, and is used to supply the lower parts of Woolloomooloo and a portion of the city along Darling Harbour, between Bathurst-street and Erskine-street. The termination in Hyde Park is about 104 feet above high water mark. The daily delivery varies much with the state of the weather, but it may be taken at somewhere between 300,000 and 400,000 gallons, which at the time the tunnel was opened was a fair supply for the population of 20,000 that then existed in Sydney. This quantity represents less than one-fifth the annual rainfall on the area draining into the tunnel. An important feature of the original scheme was to have a reservoir excavated in Hyde Park capable of holding fifteen million gallons, but this unfortunately was never carried out.

Soon after the opening of the tunnel there commenced a calamitous drought, the severest and most general of which we have any record. Cotemporary accounts represent the colony as reduced to great straits through the destruction of vegetation and live stock. One writer says:—"No words can express the miserable appearance of the country. . . . There is neither food for man nor beast. . . . God knows what will become of us all if some change does not take place very soon." I regret that I can find no record of the rainfall at Sydney, or at any other part of the colony, for the years 1838-9, during which the drought prevailed; but in Captain Stoke's *Voyage of the Beagle* there is a distinct assertion of the total absence of rain for a period of perhaps eight or nine months. He says:—"For some time previous to our former departure from Sydney, during the whole of our absence, and for several months subsequent to our return, not a drop of rain fell." Now the *Beagle* left Sydney on the 11th November, 1838, and returned 10th March, 1839. The close of the above period must have been May 29th, for I find this record in the *Herald* of May 31st:—"It rained very hard in Sydney on Wednesday night, blowing a perfect gale of wind." It is usually stated, however, that the drought did not break up till October.

There is evidence that, during this distressing period, the tunnel never altogether stopped running, although the supply became scanty. Even so early in the drought as 5th November, 1838, I find this statement in the *Herald*,—"Great distress exists in Sydney, especially at the northern end, in consequence of the scarcity of water. The stream from the pipes on the racecourse is very small—so small that the men cannot fill the water-carts **without** waiting four or five hours for a turn. Threepence per

bucket is the price now asked—a heavy tax upon poor people.” I have been assured by a gentleman who lived in the northern part of Sydney at that time that he had to pay as much as sixpence a bucket. The increasing deficiency of water led the authorities to look about for some fresh source, and the dam at Cook’s River was begun about that time with the view of increasing the supply. Speaking of the disposal of some prisoners, the *Herald* of 13th May, 1839, says,—“The men are to serve the probationary period at Cook’s River stockade, where they will be employed at the dam which is to supply Sydney with water.” This dam when constructed was not found to exclude the salt water, and no farther steps were taken in that direction.

The great drought of '38-39 was succeeded by nine years of abundant rain and frequent floods. During this wet period the tunnel seems to have kept Sydney pretty well supplied—at least I find no records of scarcity, nor of schemes for increasing the supply—but in the year 1849 there occurred a drought of considerable severity, and the water question again started into prominence. In that year the rainfall, as measured at South Head, was only $21\frac{1}{2}$ inches (the average being about 50 inches), while the population of Sydney had increased to about 40,000, or double what it was when the Lachlan swamp was first tapped. I find that in April, 1849, the Water Committee of the City Council directed the City Surveyor (Mr. F. Clarke), to examine the swamp and tunnel with the view of improving the supply. The surveyor sent in his report in December, recommending that a dam should be carried across the lower part of the swamp, so as to form a lake of 40 or 50 acres, with an average depth of four feet, and to construct a reservoir of masonry near the east end of the tunnel 25 feet higher than the lake, and capable of holding 10 million gallons; this reservoir to be filled by pumping from the lake. A commencement of the proposed dam was made, but it was soon abandoned, and the remaining part of the recommendation was neglected. The next movement was the appointment, in January, 1850, of a special committee of the City Council “to inquire into and report on the best means of procuring a permanent supply of water to the city of Sydney.” This committee did not close their labours till February, 1852, when they sent in a long and carefully-compiled report, the result evidently of a laborious investigation of the whole question. This report gives the population of Sydney at nearly 50,000 (the census of 1851 gave about 45,000, and there was a large accession about that time in consequence of the discovery of gold); the number of houses 8482, of which only 2300 were supplied with water; the assessed annual value of city property, £232,678; and the gross water revenue, £3493. In discussing the mode of improving the water supply temporarily, the report condemns

the embankment proposed by Mr. F. Clarke, and recommends instead that a trench should be dug at the lower part of Lachlan Swamp, and the water pumped from thence to a reservoir at Paddington, 207 feet above sea level. With regard to a permanent supply, the relative merits of George's River, Cook's River, the Nepean, and Lord's Dam at the mouth of the stream draining the Lachlan and other swamps, are discussed, and the preference is given to the last-named source. It is recommended, however, that this supply be supplemented by the drainage eastward as far as Bunnerong, and westward to Shea's Creek and Cook's River. Before any action could be taken on this report—before indeed it was handed in—the Governor (Sir Charles Fitz Roy) appointed in January, 1852, a board of five gentlemen to examine the question afresh. Their report (remarkable chiefly for its length) was laid before the Legislature in August of the same year. They did not take up, as the City Committee had done, the merits of different schemes, but restricted themselves to an examination of the Botany Swamps, as being undoubtedly the best available source; and they recommended that the stream flowing down from Lachlan Swamp should be intercepted at a point about a mile and a half above Lord's Dam, and the water pumped up to a reservoir at Paddington, capable of holding twelve million gallons. They held that a supply of about twenty gallons per head would be sufficient, while the City Committee assumed that forty gallons ought to be provided.

On the 1st January, 1854, the management of the city passed from the hands of an elective Council to three Commissioners appointed by the Governor; and this arrangement lasted for three years. The Commissioners took up zealously the question of water supply, and passed speedily from inquiry to action. In 1854 (a very dry year in Sydney), they erected a small pumping engine at the lower part of the Lachlan Swamp for the purpose of throwing more water into the tunnel,—by this adding about 150,000 gallons to the daily delivery; and at the same time they entered on the necessary preliminaries for obtaining a new and more abundant supply from the lower end of the stream; at Lord's Dam. It was not, however, till November, 1858, that the pumping engines at Botany were set to work, and that system of supply commenced which we enjoy at the present time. Since then we have experienced some very dry seasons, and occasionally the pumps have not been fully served by the stream; but the Municipal Council has always been on the alert, and on the whole, Sydney has been fairly supplied with water. Every dry season, however, has stimulated a fresh inquiry. In 1862 only 24 inches of rain fell, and a select committee of the Legislative Assembly was appointed to investigate the state of the water reserves. 1865-6 were rather dry, (each year giving about 36 inches of rain),

and the latter part of '67 very dry, with only $9\frac{1}{4}$ inches in six months, which had the effect of starting inquiry once more. In September, last year, a Royal Commission was issued, appointing five gentlemen to take up the search for a more abundant and trustworthy supply of water, and these Commissioners have not yet sent in their final report.

The present state of the supply is this:—At Lord's Dam, the drainage of nearly seven square miles falls into Botany Bay. The pumping establishment there comprises three steam engines of 100-horse power each, two of which are generally kept going night and day. The total quantity pumped last year was 956,000,000 gallons. A 30-inch main, about four miles long, leads to two reservoirs, one at Crown-street, 139 feet above the sea, holding $3\frac{1}{2}$ million gallons, and the other at Paddington, 214 feet above the sea, and holding $1\frac{1}{2}$ million gallons. As these reservoirs contain less than two days' supply, and as the great defect of the system is the want of storage for water in wet seasons, efforts have recently been made to form dams on the Botany stream, so as to preserve a surplus in wet seasons to make up the deficiency of dry. Six of these dams were constructed, but three were partially destroyed by heavy floods in the early part of this year. Had they remained efficient they would have provided (along with the two ponds near the engine-house) storage capacity for 250,000,000 gallons. The total cost of the works for supplying Sydney (including the two service reservoirs, but excluding the cost of distribution) has been nearly £150,000. The cost of pumping up the water last year was £4700; and if to this we add the interest on cost of plant, we find the total cost of supplying Sydney (still excluding the distribution) to be about £33 per day, or less than half a farthing per head of the population supplied. The water is distributed through the whole of Sydney proper, together with the municipalities of Glebe, Darlington, Redfern, and part of Paddington, by about 105 miles of piping.

When the present system of supply was completed in 1858, the population of Sydney and suburbs was about 87,000. At the present time it must be about 118,000. Of this number, about two-thirds share in the public supply of water; and adding the quantity delivered by the tunnel to that pumped from Botany, it appears that the distribution is at the rate of nearly forty gallons per head,—a fair supply, if only it could be kept up and fairly distributed, and all could share in it. But we have no sufficient provision for a long drought, and there is nothing to spare for thousands of people in the suburbs, or for the natural increase of our population. Supposing, however, that these defects were remedied, we should not rest content with 40 gallons per head. In a hot climate like this there ought to be a super-

abundance of water, as well for public health and safety as for personal comfort and convenience. Sydney, however, is not favourably situated for an abundant supply, and it cannot be procured without enormous outlay. The words of Sir Thomas Mitchell, in his evidence before the City Committee, in 1850, are as true and forcible now as then—"I cannot but see that the weakest point in the character of this great city, for a great city it is likely to be, is the present insufficient supply of water; I should therefore desire a more certain source."

ART. VI.—*On the Results of Wheat Culture in New South Wales for the last ten years, by Christopher Rolleston, Esq.*

[Read 2nd December, 1868.]

IN a paper which I read before the Philosophical Society in the year 1864, there was exhibited a succinct view of the results of the agricultural industry of New South Wales for the ten preceding years. I propose here to inquire into the progress of the colony in that particular branch of husbandry upon which we principally depend for the supply of food for the people, and I have thought it would be interesting to ascertain by reference to the annual returns where wheat culture has been making the greatest progress, and has yielded the largest results. In order to avoid encumbering the inquiry with too minute details, I have apportioned the colony into five divisions, namely, Southern, Western, Northern, Midland, and Pastoral. The four first divisions embrace the old settled counties, and the fifth includes the whole of the pastoral districts outside the limits of the old counties.

The table embraces the ten years from 1858 to 1867 inclusive, and is arranged in quinquennial periods to show the relative progress and results of the culture of wheat in the two periods.

SOUTHERN DIVISION.

1.—We will take the Southern Division first. It embraces the counties of Argyle, King, Georgiana, Murray, and St. Vincent. It appears that the acreage under wheat in the first five years, 1858 to 1862, averaged from 14,003 acres up to 24,718 acres, the lowest number being that for 1858, and the highest that for 1861. The average was 19,519 acres. The produce ranged from 19·5 bushels per acre in 1858 down to 9·9 bushels per acre in 1862.



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