

according to its description, and tending to produce the same effect, which it is reported to have formerly done.

13th. That during the whole interval since Freestone's Sluice was first constructed in the year 1749, to the present time, the operation of the sluice has constantly been (when in order) nearly the same, viz. that of clearing and keeping in the same good condition nearly all that part of the harbour and channel that lies between the mouth of the sluice, and the upper or south end of the Pool.

14th. That during a period of years since the year 1749, the Pool has been filling up, or growing shallower, inasmuch, that at low water, at the time of my view, there was not above six feet water.

15th. It further appears from evidence, that, for a long period of years preceding all the imbankments herein mentioned, the outfall or mouth of the channel of the harbour has lain very considerably more to the westward than at present, and that it has from time to time changed more to the east.

16th. That formerly, that is, within the compass of 20 years, the direction of the channel out to sea was N. W. and that at that time the flow of the tide being in the direction of the channel, during all the time of tide of flood, it was very easy with a proper wind to bring vessels from the sea through this channel into the pool and harbour.

17th. But that since the channel has come more to the east, and the direction gradually veered about, so as to have come now to a N. E. or N. E. by N. direction, as it was at the time of my view, it is a fact, that whenever the tide has risen above the surface of the Broad Sands, the tide still keeping its former direction from N. W. to S. E. drives the vessels across the channel upon the eastern bank or sand, and therefore without a strong leading wind vessels cannot enter without danger, and in fact since these changes have taken place, many ships have been lost, notwithstanding the skill of the pilots, to the no small disadvantage of and disparagement to the port.

18th. That the distance from the quay to the outfall of the channel is at present betwixt three and four miles, and that the channel both now lies and ever has lain, through large broad open sands, from the northward or out end of the pool to its outfall into the sea, which sand being perfectly clean, and free from all particles that might create tenacity, when dried by the sun is capable of being blown by the wind, and moved by the common agitation of the sea, and very considerable changes are wrought by the action of the sea in great storms and tempests; and that this is the description of the sands in general that lie many miles extended on this coast.

19th. That

19th. That the breadth of this sand, or distance from the pool to low water mark, has considerably increased within the memory of man.

20th. That the channel from the *Shelf* without the north part of the pool to the sea has now as much, and about the same draught of water or flow of tide at high water, as it has been known to have in man's memory.

21st. That the port of Wells is of great consequence not only from its situation with respect to the surrounding country, but also from the traffick settled in the place, and therefore that nothing ought to be done that can be of real detriment thereto.

I have thrown together the above leading facts not only for my own ease in composition, by avoiding more tedious descriptions, but that from this general view of the state of facts, I may be the more readily followed in my reasonings thereupon.

From the above there naturally arise the following questions:

1st. What is the natural cause of the decay of the harbour of Wells?

2d. Whether the imbankment in question made in the year 1758 have materially contributed thereto?

3d. Whether the removal of that imbankment will contribute to a material amendment thereof?

Question the first.—What is the natural cause of the decay of the harbour of Wells from what it has been in former times?

To have a clear and comprehensive view of the cause of *decay*, it will be necessary to shew the natural causes by which the port of Wells has been *formed*.

We are all apprised that notwithstanding the annual downfalls of rain and snow upon the land; which run into the sea in every part of the habitable globe, the quantity of water contained in the sea is never the *greater*; and this may reasonably be expected when we consider that the exhalations which form those rains and snows, are chiefly raised from the sea by the power of the sun and winds.

The floods and torrents that make their way from the surface of the land, in consequence of the rains and snows, take along with them great quantities of clayey, earthy, and sandy matter (intermixed with many other kinds of matter, which it is needless here to enumerate)

enumerate) down into the channels of the rivers, and are by the violence of the torrents carried to the sea, and there in appearance dispersed.—These kinds of matter, not being capable of being raised again, and returned back to the land, as the water is, it necessarily follows that the quantity of sandy and earthy matter that is deposited in the sea, is in a continual though apparently very slow state of increase, and by the constant flux of the tides, and the agitation of the winds, those materials so deposited are capable of being removed from the parts adjacent to their entry into the sea, not only to the neighbouring, but even to very distant parts; and though the remarkable quantity of sandy soil in the county of Norfolk may in part account for the vast quantities of sands upon the coast thereof, extending as it were in one continued chain from the coast of Lincolnshire, very much infesting the great bay between the two counties called the *wash*, and still extending coastways far beyond the port of Wells, even to Cromer, as I have been informed, yet it is by no means necessary to suppose that they have *all*, or in the greatest measure, proceeded from the land of the two counties, to the coasts of which they now lie contiguous; they may as well have proceeded from parts far more distant, and that brought hither by the incessant action of the winds and tides, they find a place better adapted to their reception and repose than those from whence they came; and indeed it may also be as well supposed that they may in *part* have come from those coasts which by the particular set of the wind and tides have been *washing* for ages past, as to suppose that they all proceed from the high lands of any place or kingdom whatsoever.

It is however of no consequence to our argument to point out *whence* they came; it is sufficient that they have come, and that being here deposited, and finding it a place where they are less liable to be carried away than they were to be brought hither, the quantity upon the whole must increase, and since there appears no power of nature by which they can be returned to the high grounds, or coasts from whence they were brought, it must follow that they must continue to increase, till some contrary power of Nature shall take place that we are not acquainted with, or the place of their reception become entirely filled.

It follows then that the attachment of sandy and earthy matter to this coast is in a *progressive state of increase*, which it is as much out of any human power to prevent, as it is to prevent the sandy and earthy matter from being washed down from the high grounds into the sea.

We need not therefore extend our views further to be enabled to see clearly, that in some former age, that is, in some state of the progression of this work of Nature, there was a time, when nothing more than a naked sand lay against the bare coast of the elevated

elevated ground upon which the town of Wells now stands, which we may suppose similar to that which now lies between *Wells Miels* or *Marram Hills* and the low water at sea, which being upon one regular decline, the tide water can flow and reflow over the surface without channel or creek; and in this state, as there would be no harbour, there would not on that account be need of a town: but let the breadth of the sand gradually increase to double, and then the declivity would become too small for the tidal water left by the flood to make its retreat so as to keep pace in its return with the ebb at sea; and therefore a body of water being thus left behind, and having a sensible declivity towards the sea, would naturally make its way into the lowest flades, and there cut a *gully*, which (if not formed gradually as may be supposed) would soon be enlarged by the influx and efflux of the tide; and thereby a scour would be produced through this passage enough to keep it open, in a degree sufficient to let the water in and out, till it became so quiet as in a manner to cease the operation of scouring; but the breadth of the sands gradually increasing, a greater body and surface of water will want a passage, and the power of scouring will increase with it; the gully will therefore by the same slow degrees enlarge to a *creek*, or *fleet* as it is here called, and lesser ones will be formed to conduct the water more readily into the larger.

The natural progress attending this operation is, that the parts of the sand furthest distant from low water, being less liable to agitation from winds and tides, the sand intermixed with the finer particles of earthy and clayey matter brought in by the tides, are the most readily and quietly lodged there; and particularly the earthy and clayey particles will find a resting place, which binding the sand together, the whole will continue to rise, till at a certain height, and in consequence of a certain length of time of absence of the salt water each tide, and exposure to the sun and air, the surface becomes fitted for vegetation, and by degrees will grow a certain species of grass, and become a salt marsh; the grass again entangling and locking up the earthy matter, will cause it to continue to rise, and in an increased ratio, as the water upon the plain grass surfaces becomes more shallow, and in consequence more still, and free from the agitation of external disturbing causes.

During this period, as the marshes have increased in height, they have also increased in breadth, and in consequence a greater body of water will be left upon them; the gullies and creeks therefore, as they multiplied in number with the increase of breadth, the larger ones would increase in size and depth, and if all were ultimately collected into one, as has been the case with the channel of Wells Harbour, the scour would be sufficient to maintain a channel through which vessels might be brought from the sea, and thus

thus an useful Harbour would be formed, which would increase in depth and utility by the continuance of the forming powers, but yet, only to a *certain degree*.

I have said that, as the marshes increased in breadth and height, more water wanting a passage to the sea would be left upon them; and this, so far as regards breadth, is self-evident; but as the increase of height diminishes the depth of water upon them at high water, that the quantity left behind upon the whole will be greater, needs some explanation. In respect to this, it is obvious to every one who views the subject, that while the depth of water upon the marshes is considerable, the water makes its way to sea by settling gradually, and passes off in the nearest direction over the marsh surfaces, without having any need for the gullies and creeks as drains; it is therefore perhaps only the last half foot that may need the gullies; which, however, being limited to some certain thickness (be it half a foot more or less), and this thickness much less than the depth at high water, the quantity so left will be in proportion to the quantity of surface; and the number of gullies, being also in proportion to surface, the aggregate of the whole and the scour thereof in the last channel will also be proportionably increased; it is likewise remarked, that in fact, the scour is not very material till the water upon the marshes has ebbed near their surface, that is, until it is just retreating into the gullies, when the principal scour begins.

Under these circumstances, the scour would increase and consequently the goodness of the harbour of Wells would naturally improve, while the neap tides covered the surface of the marshes; but as the same progression would in time cause the surface of the salt marshes to rise above the ordinary neap tides, the scour would then begin to diminish, because, being not only deprived of the efflux of the water from the grass surfaces into the gullies a number of times in a fortnight, the scour of these gullies becoming immediately less, they would themselves begin to choak up, and contain less *following* water; and therefore, in both respects, the scour being diminished in each particular gully, the scour of the whole must diminish.

It is most probable that this harbour, from the slow progress of the changes above specified, may have continued in a very flourishing state for a long term of years, reaching backward beyond all record; though it is likely that for a part of that time it may have been in reality in a state of decay, and which we will now shew will naturally result from the same progression of causes that carried it to its *maturity*; so that after having clearly seen from what natural causes the Harbour has been produced out of the sea without a fresh water river to give it birth, we shall then see the natural causes to which its *decay* must be attributed.

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From what has been laid down, it will appear most manifest that the rising or elevation of the surface of the salt marshes, by a fresh accession of sea mud which they will acquire more or less every time they are overflowed, will not stop at the *neap tides*, but will gradually rise higher and higher towards the high water of spring tides; and if after that they were only to be overflowed in the great springs or raging tides, yet as every one of these tides will deposit something, they will ultimately be shut up at the height of the extreme high water, though no *imbankment* whatever was to take place; and this will also happen in succession to the gullies, creeks, &c.

For as the surface of these marshes rises higher and higher from the neap towards the spring tide mark, they will be less and less often overflowed, and the gullies made by the reflux of the tidal water from their surface will become less and less capacious, and in consequence of a want of reflow, the creeks will suffer the same fate, and lastly, the *fleets* and *main channel*: But as the tide water flowing in through the channel, fleets, creeks, and gullies, to the several extremities of its branches must flow back the same way, it is the extremities that will be first landed up, because every part betwixt such extremity and the sea will have water beyond it to flow over or through it, and thereby producing some degree of a scour, will keep open a passage either greater or less, while any water can get beyond it; and hence we must expect, that the parts of the channel most distant from the sea will be those that in a state of nature will soonest lose their depth and capacity, till progressively, from the extremities towards the sea, the gullies, creeks, fleets, and main channel will become solid land: and so far it appears from testimony, that long before the imbankment in the year 1758, nature had got on so far in its progress in the decay of Wells Harbour, that it was much complained of; and the upper part between the quay and the pool was got so bad, that the goods were in general lightered up to the quay, and that for remedy thereof, Freestone's Sluice was built in the year 1749, which produced a good effect in clearing that part of the Harbour. As then it plainly appears from the preceding discourse, that the progression of nature has no tendency to cure the evils complained of, but still to increase them, they are in consequence incapable of any remedy, except what can be applied by the ingenuity and labour of man.

We now come to the 2d question, whether the imbankment made in 1758 has materially contributed to the decay of the harbour of Wells?

From what has preceded it has been clearly shewn, that as the keeping open and maintaining the channel entirely depends upon the reflow of the tide water, or *back water* as it is called, whatever cuts off and diminishes this, must be a detriment to the scour, and consequently to the maintenance of the channel; I therefore do not hesitate in saying that

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that all the imbankments both east and west of the town of Wells, the water received upon the surfaces of which, and into their gullies and creeks, used to make its way back to the sea by the channel of Wells Harbour, must have co-operated with the progression of nature, and thereby tended to bring on more speedily a general want of depth, which, as it has been already remarked, will be first perceived at those parts of the tidal flow the most remote from the sea; nay, we may go so far as to say, that if a bucket of water were taken up in the upper part of Wells Harbour, and not suffered to reflow, it might prevent the displacing of some particle of matter that had been lodged therein by some preceding tide. In this sentiment I suppose every able engineer and skilful person that has viewed the premises will join as a *general opinion*, but though very true as a general sentiment, yet the whole merit of the question depends upon the *quantum*, the *how much* damage could result from those artificial means; and as in this it appears that the opinion of different men have widely differed, I will proceed to state my own with all the precision and clearness I am able.

Now, if the breadth of the sands continue upon the increase, we must conclude that the reflux of the tidal water from the whole surface covered continues, upon the whole, if not greater, as great as formerly, and therefore will maintain as good a channel to sea at the outfall at low water; nor does it appear from any testimony that, from the scalp to the outfall of the channel into the sea, there is a less depth at high water than formerly existed; the complaints and appearance of a diminution of depth of the harbour are from the lower or north end of the Pool upwards towards the town. It appears therefore, that the upper part of the channel that lies contiguous to the main land is *landing up*, and that in fact the harbour is moving *towards the sea*.

It does not appear from testimony that the filling up of the Pool, or its growing shallower, so that ships cannot now lay afloat or swing round in tiers as they used to do at low water, has been a matter very much complained of till after the imbankment of 1758; but this does not disprove that the fundamental cause thereof may have existed long before the ill effects have become sensible to seamen, and those using the harbour; and indeed it clearly appears to me, that the filling up of the Pool sooner or later, is only a link in the general chain of causes that must have operated so as to produce this effect, whether any imbankment had been made or not.

To see this clearly we have nothing to do but to advert to the situation of the Pool, for it begins just below or about where the *West Fleet* falls into the main channel. This Fleet received the drainage and back waters from the *Holkham* marshes, which appear to have been anciently of much greater extent than at present, and consequently the back water or reflow

must have been very considerable from this great extent of surface, as well as that which still lies unembanked, and which being joined by the great reflow of back water from the East Fleet, the Little Fleet, and the Haven Creek, with all their extensive dependencies, must have formed a great and rapid scour of back water, especially when it is adverted to, that it is confined within a narrow compass between the Holkham and the Wells Marram Hills or Miels; we must therefore expect no less than a very deep channel in this extent, well deserving the name of *The Pool*. And that this confinement of the whole water both of flood and ebb, between the hills just mentioned, gave an additional scouring power to the tidal water, appears further from this, that the Pool never appeared to be of further extent northwards till this opening between the hills being cleared, the tidal water having an opportunity of escaping on tide of ebb over the broad sands lying without those points, its force became dissipated, and the great and sudden scour ceased, that caused this deep water even in that age when the whole scour was in its greatest degree of strength and perfection, and the depth and goodness of the harbour consequent upon it. But whenever (as has been shewn) the scour beyond it became diminished by the rising of the marshes above the high water of *neap tides*, the depth of the pool would begin to diminish, for the scours would then be unable to scoop out the sands from so great a depth as before, that would be continually brought in by the N. W. winds at *Holkham Gap*, from the broad sands lying to the north thereof, and then by the West Fleet carried down into the Pool.

Nor is the Holkham Gap the only source from whence the sands brought down by the West Fleet might be collected; for I look upon it that the inside, that is the south side, of the Holkham Miel Hills, is continually melted down by winds and rains into the great area or bay drained by the West Fleet, while those hills are continually supplied with fresh sand blown up by the force of the N. and N. W. winds upon and over them, from the broad sands that are yearly extending more and more from thence to the northwards into the sea; the highest parts of which broad sands being frequently left at *neap tides* long enough to be dried by the sun, are by the wind capable of being blown up in great quantities, so as to raise and continue those hills far above the high water of any tides whatever, though composed of nothing more than a blown sand from the sea, somewhat united by the bent grass that grows up through the same, of which there are very many examples in various parts of the kingdom.

In that age when the scour at the pool was in its full perfection, it is probable that it was very much deeper than it has ever been reported by any testimony or record now extant, and so long as it continued deep enough for the purposes of shipping, there would be no cause for complaint; and till it became too shallow for ships to swing at low water,

its diminution of depth would be little regarded. There is therefore no doubt but that the Pool was growing shallower long before the imbankment of Holkham marshes, as a considerable length of time must have elapsed between the period when Holkham imbanked marshes were just rising above the high water of neap tides, and their acquiring the height at which they were imbanked; and which height I judge was not materially different from the present.

When the ground of Holkham marshes was become high enough for embankment, the natural scour arising therefrom was diminished from what it had been, and though they had not been imbanked, would have been still much less at this day. Yet so great a surface as 560 acres, the drainage of which plainly appears by the map to have made its way out to sea by the West Fleet, being cut off all at once in the year 1719, and 108 acres more in the year 1721, the whole of this together amounting to 668 acres, may reasonably be presumed to have had some sensible operation in accelerating the effects that nature in her progression would afterwards have brought on, though no artificial imbankment had been made; but it by no means follows, that the effects of those imbankments must be *immediately* perceived at the Pool. This by slow and imperceptible degrees must be supposed going on as before, and by less slow but yet imperceptible degrees might be going on after; yet this must be attended to, that in proportion as the scour of the west fleet was diminished by the loss of the imbanked marshes, the power of the same scour would be diminished to carry down the sand continually into the pool, as it before used to do, so that till the great bay that still continues to be drained by the west fleet, as it were gorged with sand from Holkham Gap and Holkham Miels, it would not be brought down in so great quantities each tide as before the Holkham imbankment; and therefore as it appears that the whole progress of this business is very slow, it must be expected to have been a series of years between the *cause* from the Holkham imbankment and the *effect* becoming more perceivable in the sanding up of the pool; and in case this necessary period of years extended from the year 1720 to the year 1758, that is near 40 years, at which time the last imbankment was made, then those would become *cotemporaneous* events, and it would be no wonder that the united effects of the Holkham imbankment, and that of the Church marshes in the year 1719; and also of the West marshes of Wells in the year 1720, making in the whole 572 acres, together with the additional loss of scour from the surface of the salt marshes which yet remain unimbanked to the amount of between 15 and 16 hundred acres, the drainage of all which have their outfall through the Pool; I say it would be no wonder if under these circumstances the united effects tending to land up the pool should be charged to the account of the imbankment made in the year 1758, if it were possible to suppose that the imbankment made that year of 64 acres could have a sensible effect, for the object of this imbankment amounted to no more than $\frac{1}{34}$ part of the

the whole quantity concerned in producing it; when it remains *problematical*, whether the effect of the 572 acres taken in before, which is near nine times as much, would *alone* have been sensible, if the effects thereof had not been mixed with what might have arisen from nature's simple progression, in case its operation had been no ways disturbed by that of art.

I find myself therefore forced by fair induction to infer, that though strictly speaking the effect of every thing that has an effect must be *something*, yet that the imbankment of the salt marshes in the year 1758, could not in any sensible degree capable of measure or estimation contribute to the landing up of the pool.

The effect thereof upon the outward part of the channel must be still more remote; for it does not appear from any principles of art, observation, or practice, that when a back water, even assisted by a fresh water river ever so large, makes its way through broad moveable sands, it has any tendency in itself to make its way out to sea in this direction more than in that. The natural tendency of water is to make its way in whatever direction it finds the *greatest declivity*; and if that happen to be in the shortest direction, it has no natural tendency to gain a longer course, as that would lessen the declivity: If therefore water is found going in a course that is not the shortest, we may conclude (and on examining we always find) that this longer course is owing to the intervention of some object so placed, that the water can have in that particular part a more speedy descent in a direction different from that which would form the shortest line of the whole descent; and from causes of this kind a stream may have a course in every possible degree meandering that we frequently observe in nature.

If therefore the course of the out-fall channel to sea at low water was in a north-west direction through the broad sands, as it seems very well attested to have been in former times; and if at those times the course of the channel corresponded with the general set of the tides upon the coast, so that vessels going in or out through the out-fall channel were not driven out of their proper course by a set of the tide *cross* the channel, as is said to be the case at present; it may be imputed to some of those lucky causes that operated in favour of those times, as no strength of back water alone could have a natural tendency to produce this effect: And if the accidental operation of contrary causes, as suppose winds and tides, either considered alone, or as acting in correspondence with the regular progression of nature already described, has brought the direction of the out channel into a situation less favourable to navigation than it used to be formerly, at the same time that it has produced a shorter course for it to sea, than it would have if returned to its former direction; I am therefore clearly of opinion, that no increase of back water, even if aided by a fresh water river, if artificially brought down