ON REGULATING THE FLOODS AND IMPROVING THE NAVIGATION OF THE ERNE AND SHANNON RIVERS.*

By Mr. L. Lynam, C.E.

The Erne and Shannon rivers have three features, which render it peculiarly easy to regulate their floods, and prevent inundations. They have large superficial areas of lakes. Their channels between the lakes are wide and deep, so capacious as to carry their floods with an inclination of less than an inch a mile. Their floods rise slowly, 4in. to 8in. in twenty-four hours, very rarely rising 1ft. in twenty-four hours. The Shannon has a fourth feature very remarkable. All the mill-weirs and fish-weirs have been purchased and removed, and all the shoals have been deepened at a cost of £529,716. The lakes in the Lough Erne basin have an area of about 50,000 acres. The shoals and straits, which obstruct the river and cause the inundations, have an aggregate length of merely 6 miles. Only one mill-weir (which is the only fish-weir) exists, and it is at the outlet where there is a fall of 12ft. The Shannon basin has lakes of the superficial area of 87,000 acres. In the length, from the Battle Bridge above Carrick-on-Shannon to Killaloe Bridge, of 128 miles the lakes occupy 50½ miles; the broad, deep channel extends for 73½ miles; the confined portions of the channel occupy merely 4 miles; the portions of the channel confined so as to be visible obstructions are but 2 miles long. Neither mill-weir nor fish-weir stands in the way of the current. The floods scarcely ever rise 1ft. in twenty-four hours. The great floods are but 4ft. where deepest on the lands, and generally but 2ft. deep, and merely 18in. deep over large areas. Many damaging floods are not more than 6in. deep on the land. The Shannon river is accurately shown on the Ordnance map, on a scale of 1in. to a mile. It rises in a rather desolate valley among the Co. Leitrim mountains, in latitude 54 deg. 14 min. 3 sec., and longitude 7 deg. 55 min. 7 sec. Its source is a circular basin, locally called the Shannon Pot, 55ft. in diameter, and about 20ft. deep. The water is of a fine, clear, blueish colour. When I saw it in 1875 its surface was 5ft. under the land, and the stream from it was but 3ft. wide and 2ft. deep. In wet weather it rises over the level of the land, and an immense quantity of water issues from it, and rushes down 11½ miles to enter Lough Allen, which is 7 miles long. From Lough Allen to the tide of the Atlantic ocean at Limerick, a length of 149 miles by the sinuosities of the river, the Shannon has been made navigable for steamers, with a depth of 6ft. of water. The river lies naturally in eight separate levels, but the lowest, at Limerick, is very small, and detached from the others by a length of five miles, and a fall of 90ft. The upper level, at the outlet from Lough Allen, has a fall of 20ft. in six miles, and affords no matter for discussion here. Therefore we will consider only the six levels from Carrick-on-Shannon down to Castleconnell. The lowest level between Castleconnell and Killaloe is but small, containing only 641 acres of lowland, rarely flooded in summer or autumn, and rarely covered by more than 1½ft. of water. To preserve the land from summer and autumn floods the surface of the flood must be lowered 2ft. nearly. A permanently solid embankment, used during many years for a navigation horse tow-path, extends along one side of the river, the only openings being four culverts for side drainage. A mere trifle would make it a complete protective embankment. On the other side of the river there fortunately exists a natural ridge, which is a little higher than the highest floods. It is not continuous, but interrupted in five places. These circumstances render it very easy to protect the lowlands from all floods. Very favourable sites exist for back drains to carry off rain water and springs. The 641 acres of lowlands may be thus protected from summer and autumn floods at a cost of £5000, being £10 per acre. This would allow of winter irrigation also, which the occupiers of the lands particularly require. The system of river embankments is much objected to as dangerous, and properly so, when it is proposed to make high embankments. In this case the required embankments are in existence for seven-eighths of the required length, so permanently solid as to be absolutely safe, and the small portions to be built need not be more than 3ft. to 5ft. high. The obstructions are a rock-shoal near the middle of the length; an old bridge with narrow arches and thick piers, and a shoal of solid limestone rock at the outlet. To enlarge the channel in those places, so as to make it carry the floods at a level low enough to preserve the lands require:—

33,397 cubic yards of excavation in clay	.. ..	£2,194
55,725 „ „ in rock	.. ..	6,965
A new iron bridge, three 70ft. spans	.. ..	2,500
A new regulating weir	.. ..	9,525
Land for spoil	.. ..	400
Temporary division of water	.. ..	1,000
Total	.. ..	£22,584

This amounts to £37 an acre on the 641 acres to be relieved from summer and autumn floods; contingencies £2258; total £24,842. This amounts to £38 per acre on the 641 acres liable to autumn and winter floods. The Shannon floods may be well studied in three classes, viz.—the small floods, great autumn floods, and great winter floods. The small floods have occurred every year and in every month. In a period of twenty years they do more harm than great floods. They have kept the land saturated and cold during March, April, and May, which has prevented the growth of good grass, and promoted the growth of sedge and weeds. This herbage grows only late in the season, and is late in coming to maturity. The mowing of the crop is thrown back into the rainy season, the saving of it is laborious and expensive, and often impossible. In the large flat meadows there are three qualities of hay, viz., sedge, mixed with tall, soft weeds, which is set at from £2 to £3 an Irish acre; the second quality is brown bent grass, with some natural ryegrass, and great quantities of meadow sweet; this is set at from £4 to £5 an Irish acre; third, timothy grass, phlenm, nodsann, excellent hay for hunting horses, and is set for £6 to £8 an Irish acre. I have dug up the soils of the three qualities of meadow, and failed to discover any difference. The difference of the values of the meadows results from a difference of the levels of the lands. The good "Timothy grass" meadow lands are 12in. to 15in. higher than the others, and are consequently above water a month earlier in spring, when they shine forth beautiful, bright green islands. The sedgy, weedy meadows are the lowest by some inches, and are saturated longer than the others. The kindness of the soil of these is evinced in many places by the following interesting fact, viz.—on examining the surface closely, numerous plants of clover and some fine species of grass are to be seen, healthy, but small and distant. Of course, if these lands were freed from saturation in spring, summer, and autumn, the clover and fine species of grass would flourish and extend to a material degree, and in a few years the meadows would become much increased in value. The aggregate amount of injury to the crops from the small floods in thirty years far exceeds the aggregate amount of damages that have actually occurred from the one great autumn flood that had occurred within that period. The quantity of water flowing off in the river at Meelick, from a rain basin of 2,500,000 acres—400,000 square miles—is, in all those small floods, under 300,000 cubic feet per minute. The present river channel is fully broad and deep enough, and has fallen enough to carry off that quantity and more at a moderate velocity. The only obstructions, then, are the weir-mounds. While all the low land for 120 miles lies steeped in water, the weir-mounds, with a fall of several feet at each, but without any sluice or floodgate, act as permanent artificial barriers to the flow of the river. Fifty lineal feet of open sluice in each weir would relieve all the low land, and increase its value accordingly. One great autumn flood only has occurred in the Shannon within the last thirty years. It destroyed the whole of the crops on 16,300 acres, and injured 3000 acres more. It began to go out on the ground at Portumna on the 13th of August, and rose 1ft. 3in. in five days. It remained at that height for five days more, when it began to fall. The very lowest lots of land were covered by water 1ft. 3in. deep. The large areas of meadow there were covered nearly 15in. deep. The flood began to fall on the 24th of August, and continued to fall at the average rate of 1in. a day till the 9th of September. Then there was no water on the meadows, and so it remained till the 23rd of September—fifteen days—but the water in the river and drains was even with the surface of the land. In working at the hay, men's feet sank into the ground. Muddy water rose after them, and it was impossible to save the hay. It is important to note well here two things—how slowly the flood rose on the land—merely 22in. in six days, or 3¾in. average in twenty-four hours—what a small depth of flood water there was on the land—20in. depth of water for four days, 17in. depth of water for twenty-seven days. Then saturation merely for fifteen days, up to September 24th. Another very important fact to note is that there is no obstruction whatever in the Shannon, at or near Portumna, to prevent the free flow of the Shannon into Lough Derg, which is a wide, deep lake 22½ miles long. This wide, deep water having no appreciable fall in the surface, goes to within 1000ft. of the great weir mound at Killaloe. The channel for this 300ft. is 450ft. wide, and 73ft. deep of running water, with an inclination of 1¼ft. per mile down to the weir. Over the weir-mound there is a sudden fall of the water of 2ft. 2in. This diagram represents accurately the relative levels and inclinations of that flood above, at, and below the Killaloe weir. It is drawn by myself, from levels taken by myself there in August, 1861, when the flood was at its highest. There was as measured by me, in the height of that greatest of autumn floods, in August 1861, a cataract, a clear fall of 2ft. 2in. over the weir. The river channel downwards to Killaloe Bridge was more than 450ft. wide, by more than 6¼ft. deep, with a surface inclination of more than 2¼ft. per mile. From the bridge downwards there is a fall of 4ft. in a quarter mile, as shown on this diagram section. I ask was not that weir-mound on that occasion a great obstruction? Evidently it was. If that weir-mound had not been there on that occasion where would have been the flood surface from its site up to Portumna and Meelick? I submit for your consideration that they would have been as follows:—Let a line be drawn from the surface of the water below the weir upwards to the broad, deep water, and parallel to the surface of the flood river, as it was on the 21st August. Had the weir not been there the surface of the water a few feet above the site of the weir would have been a fraction of an inch higher than that line, and 300 yards upwards, which is above the head of the shoal, and in Lough Derg, it would be 4in. or 5in. above that line. The flood water would be running in a column 6ft. deep instead of 8ft. deep, and must run faster, and must have a greater inclination. The velocity in the 8ft. deep channel was 250ft. per minute; in the 6ft. channel it would be 330ft. An increase of 5in. or 6in. in the surface fall from the broad deep water to the site of the supposed removed weir mound would suffice to increase the velocity so as to carry off the same quantity of flood water, with 2ft. less depth, as required. Of the 2ft. 2in. that would be gained just above the site of the supposed removed weir 6in. would be lost in generating the required greater velocity for the shallower channel, and 20in. would be gained in Lough Derg, and by that lough the same would be gained at Portumna—that is, the flood water would have been 20in. lower there. But the meadows were covered by 20in. only of flood water, and that merely four days. Therefore, if the weir mound had not been at Killaloe in August, 1861, the low lands at Portumna would not have been covered at all by flood water. They would have been saturated for eleven days. Instead of having been flooded from the 14th of August to the 9th of September, they would have been merely saturated from the 18th of August to the 28th of August; and thenceforward all the lands would have been quite dry till the end of September, and all the crops might have been saved. If the Killaloe weir mound were removed, and replaced by a movable regulating weir, another important element would come into favourable action. The immense capacity of Lough Derg as a storage reservoir, hitherto valueless, would be utilised. The lake contains 50,000 acres—33,200,000 square feet. The proper level for steamboat navigation, proposed and recommended by the Shannon Commissioners, and legalised by the Shannon Act, is 2½ft. under the surface of the meadow land. The capacity of that reservoir is 48,000,000 cubic feet. When the great rainfall occurred on the 15th of August, none of that storage was available. The lake had been filled up gradually during the previous month by ordinary wet weather and small floods. It might have been all available that time. The quantity of water then, and during the previous month, was under 400,000 cubic feet per minute. The channel, as it then was, and now is, was fully capable of carrying off that quantity at the navigation level, and keeping the surface of the Shannon river and of Lough Derg the full legal 2½ft. under the surface of the low lands. Had it been so, the rise of 21in. by the rainfalls would have left that lake surface, when highest, some inches under the low lands. Forty wholly removable, regulating weirs were constructed in the Seine several years ago. When wholly closed up in summer, they maintain the required depth of water for a valuable steamboat navigation. When wholly open in floods, they cause no stoppage in the river surface. A remarkable barrage mobile has been in excellent action for several years at a place called Port à l'Anglais, above Paris, and above the junction of the Seine and the Marne. I saw it when all open; there was not a ripple on the river flowing by. I saw it raised and lowered with ease and facility. I have here a letter from M. Gambuzat, the chief engineer of the river Seine, in which he informs me that all these wholly removable regulating weirs in the Seine are remarkably effective and suitable for regulating that great commercial river. In 1862 I made an engineering tour of the river Soine, and saw and sketched those weirs. They act well, but I have another design more suitable to the circumstances of the Shannon. Let me now put forward the following proposition:—If in July, 1861, a month previously to the great flood, the Killaloe weir-mound had been wholly removed, and a wholly removable weir like that in the Seine at Port à l'Anglais had been constructed, and subsequently been properly manœuvred, during the month of August, none of the crops in the level of the Shannon, above the Killaloe weir-mound, would have been materially injured. No other flood of so great magnitude as that of August, 1861, has occurred in summer or autumn during the last thirty years. I am not asserting that the weir in the Seine at Port à l'Anglais is the most suitable pattern weir for the Shannon at Killaloe, but I assert that, such as it is, if one like it had been built in the Shannon at Killaloe, and judiciously manœuvred during the past thirty years, but little material damage would have been done to the low lands governed by it. The official registries of the heights of the water over the lock-sill show that—First, the surface of Lough Derg has never fallen so low as the level of 6ft. over the lock-sill; second, that the lowest level to which it ever has or ever can descend is 7ft. over that mark; third, that for a great part of every year it is 8ft. to 9ft. over that point, and often rises 10ft. over it. Therefore, the level of the Shannon from Killaloe upward, for thirty-one miles, to Meelick, is, and has been for the last thirty years, artificially penned up to levels varying from 1ft. to 4ft. higher than the parliamentary plans warrant. This has been done and maintained by the commissioners, in violation of their own plans and of the Act of Parliament 1 and 2 Vict., c. 61, and to the great injury of the lands for thirty-one miles upwards. The navigation for steamboats is a little better than it was before the works at Meelick, but it is far worse now in floods at Killaloe than it was before the works were planned. What was before a still water canal is now a torrent in floods. In mid-floods the passage is dangerous; in high floods impossible. It may be restored to its former tranquil state of water by building a concrete protection wall where the protection bank was, which the commissioners foolishly cut away. Some more works are required for improving the navigation at Derry Island and White's Ford. The old canal at Meelick should be cleaned and improved. I now submit the following propositions:—(1) The circumstances and features of the Shannon river render it very easy to regulate its floods and protect the lands from injurious inundations. (2) The drainage and the navigation may be improved to the fullest extent necessary or desired for a third part of the sum which the Government has been advised to assist in spending. (3) This may be effected by means of movable regulating weirs which may be all built in one season, and by dynamite blasting and steam dredging. I have all the details necessary to prove this for each level of the river. No more surveyors or plans are necessary. I have accurate large scale plans, and sections of all the straits and shoals, and the *rental* of the river tabulated for its present and for the proposed state in floods.

* British Association.

THE TORPEDO VESSEL DESTROYER.

We mentioned in our issue of April 20, that Captain Ericsson was constructing a vessel for handling the new torpedo which attained such marvellous speed during the trials on the Hudson, reported to the Ordnance Department December 7, 1877. This vessel is now completed, and was launched into the Hudson from the wharf of the Delamater Ironworks last Saturday, steam engines, propeller, and other machinery being attached and ready for action. The boilers, owing to their great weight, could not be placed on board before the launch, as the vessel had to be lifted into the water by floating derricks. The launch excited much attention from its novel character, the vessel being hauled on a level from the interior of the boiler-house to the bulkhead on the Hudson. The steam engines of the establishment in connection with powerful tackle being employed, the vessel was hauled, stem foremost, along the level ways with much facility. When arriving at the bulkhead of the river, the direction of which was nearly at right angles to the ways, the vessel, by an appropriate change of the arrangement of the tackles, was pushed forward until the stem reached some 30ft. beyond the bulkhead. A derrick placed in the line of keel was then used to lift the forward end of the structure by a series of straps passing under the bottom in such a manner as to divide the strain over a considerable distance of the bottom. The lifting gear of the derrick was next applied with sufficient force to relieve the pressure on the ways. At this moment the derrick scow was backed into the river, while the tackle operated by the stationary steam engine pushed the body still further beyond the bulkhead, until only 40ft. of it remained on solid ground. A second derrick was then brought close to the bulkhead which, by means of straps as already mentioned, lifted the stern above the ways. The vessel being now wholly suspended in the air, both derrick scows were backed into the river, the action of the derrick gear reversed, and the Destroyer lowered into its future element.

The form of the hull is very peculiar, both ends being precisely alike, terminating with very fine wedges, probably sharper than any vessel of deep draught yet built. The length is 130ft.; depth, 11ft.; beam, 12ft. extreme, thus presenting the unusual proportion of eleven times greater length than beam. The rudder of the new craft requires special attention, as it is wholly unconnected with the visible part of the stern, being attached to a vertical wrought iron post welded to a prolongation of the keel, just aft of the propeller, its upper part being nearly 4ft. below water line. The tillers consist of thin plates of iron rivetted on opposite sides of the rudder, a few inches from its bottom. These tillers are operated by straight rods connected to the pistons of horizontal hydraulic cylinders of 5in. diameter attached to the sides of the keel. Accordingly the steering gear will be placed 10ft. below water line, while the top of the rudder only reaches within 4ft. of the water line. The professional reader cannot fail to institute a comparison between this thoroughly protected steering gear and the invention of M. Lafargue, now attracting much attention at the Paris Exhibition. M. Lafargue's device not only exposes the upper part of the rudder head to an opponent's fire, but his hydraulic cylinder is actually placed above the same and several feet above the water line.

We do not propose on this occasion to enter on the laborious task of giving a complete description of the mechanism of the Destroyer, but we cannot abstain from adverting briefly to the fact that the intention is to render this vessel so far impregnable that in attacking bow on, it can defy the opponent's fire, offering absolute protection to the commander and helmsman, as well as protecting the base of the smoke pipe.

The leading feature of the construction of the hull is, its being provided with an intermediate curved deck extending from stem to stern, composed of plate iron strongly ribbed and perfectly water-tight. This intermediate deck sustains a heavy solid armour-plate placed transversely to the line of keel 32ft. from the bow, inclined at an angle of 45 deg., and supported on the aft side by a wood backing 4ft. 6in. deep at the base. The steering wheel is applied behind this wood backing, a wire rope extending from its barrel to a four-way cock near the stern, by which water pressure is admitted alternately to the hydraulic cylinders at the stern, the motion of whose pistons actuate the rudder. The lower division of the vessel is supplied with air for supplying the boiler furnaces by powerful blowers drawing in air from above.

It is hardly necessary to state that during attack the Destroyer is intended to be as deeply immersed in the water as the monitors; but this deep immersion need not alarm the ship's company as it sometimes did in the "cheese boxes" during the war, for a deck-house or cabin 70ft. long, composed of plate iron, is rivetted water-tight to the upper part of the hull. As this cabin, which has no opening in the sides, virtually forms part of the hull, it would be safe to run with the upper deck considerably below the water-line. Owing to the stated peculiarity of construction, the constructor says that the new torpedo vessel will live at sea in any weather, more particularly since its stiffness is most extraordinary, an advantage resulting from the circumstance that the bottom must be heavily ballasted in order to insure deep immersion, there being no other weight placed between the two decks than cork and inflated air bags.—*The U.S. Army and Navy Journal.*

Steam Steering Gear.—One of our correspondents in Lancashire writes:—"A new steam steering gear, patented by Mr. Harrison, was on Wednesday exhibited for the first time at the works of Messrs. Hodgson and Stead, engineers, Salford. By this invention Mr. Harrison claims to secure to the helmsman a perfect control over the steering engines, and also to do away with the noise which is so objectionable in the apparatus now in use on some of the steamships. The first object is attained by means of a rotary disc valve operated upon by the steering wheel, which cuts off the steam automatically and controls the action of the piston rod to within ⅛in., the engine, in fact, responding instantaneously to every motion of the steering wheel, whilst the noise is obviated by the substitution in the working gear of a worm in the place of the usual wheels and pinions. It is also claimed that the engine will exert the power of twelve men on the rudder, which will be kept steady however rough the action of the sea may be upon it. The working of the apparatus appeared to give satisfaction to a number of gentlemen who inspected it, but I understand it is shortly to undergo a practical test on board ship at Liverpool.