

## THE MITIGATION OF FLOODS IN THE HUNTER RIVER.

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## I. INTRODUCTORY.

The floods in the Hunter River arise from different causes, making their manifestations felt in different parts of its course. For example, the 1857 flood was (I understand)



an Upper Hunter flood. The 1893 flood was of a different character. It arose from rain in the Lower Hunter, which was mainly confined to the eastern and southern slopes of the Main Range parallel to the coast, and thence sea-ward. The rain-clouds came, I understand, mainly from the south-east and contact with the range induced the downfall. Such a flood being local, no engineering or other skill applied to the Upper Hunter could affect matters. Recently I examined the Upper Hunter and its tributaries, with the view to see if, from the point of view of the forester, I can make any suggestions reasonably calculated to mitigate, to any degree, the disastrous effects of floods in the Hunter.

Although I have paid scores of visits to various parts of the river, I do not wish to assume that my knowledge of the stream is as perfect as I would like it to be. I have however, carefully used my opportunities of studying the Hunter River question, and can only express the hope that my suggestions may be considered, especially as I have no sensational panacea to offer. I travelled the district during the heavy rains of August 1899, when the creeks, such as Stewart's Brook and Moonan Brook, were raging torrents, making an instructive contrast to their present state; now (May 1902) they are creeks nearly without water. In that year I saw the banks abundantly fall in and my trip was therefore in a measure more instructive than in 1893, when one's opportunities for observation were very limited. At the same time I inspected the devastation of the 1893 flood as soon as travelling was possible, and am cognizant, in some slight degree, with its effects.

## II. GEOGRAPHICAL NOTES.

Mr. Napier Bell in his report<sup>1</sup> says, "The Hunter Valley from the sea to very near the top of its watershed, is the

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<sup>1</sup> "Flood Prevention in the Hunter River," Legislative Assembly, 1899, p. 3.



finest and most fertile valley I have seen, and I do not think there is any like it in these Colonies." It will be at once admitted that the valley is one of the most valuable heritages New South Wales possesses, and hence the interests at stake in its welfare are of no ordinary magnitude. The river rises in the Mount Royal Range and in very many parts of its length runs through rich black soil flats, some of them quite small, but in the aggregate amounting to a considerable area.

The Page River is an important tributary of the Hunter and there is much rich land on its banks. This river has been settled for many years and its banks show much evidence of erosion. Extensive washaways are evident between Muswellbrook and Denman. There are now large reaches in the river both here and in other places, and it is pitiable to see the deep sections of rich land doomed to fall into the river bed and be washed away at every fresh. The Hunter is every year becoming broader and shallower. In seasons of drought such as the present, this is a matter of special consequence, as the waste of water through increased evaporation must be enormous.

The Goulburn River is the most considerable tributary of the Hunter, which it enters on its right bank, near Denman. It is said that this river brings down a larger body of water than the Hunter at the place of their junction, and hence it is believed by some people that it is this river that causes the greater portion of the mischief at Maitland, etc. The Goulburn River silt is by no means all sandstone, *e.g.*, Bow Creek flows through rich volcanic soil for a large portion of its course. The Wybong Creek shows washaways like the Hunter River creeks; there appears to be no very serious erosion of the Krui (another tributary of the Goulburn) at present, although the river appears to be widening about Collaroy.



As regards Merriwa Creek, the banks have broken down and have carried the rich alluvial soil with them, as in many other places. The soil of Merriwa appears to be *sui generis*; it is of specially fine texture and hence can only be used for crops with difficulty. At present we have very few data enabling us to classify the soils of New South Wales; in a few years no doubt we shall have a "soil-map" of the State, and then it will be realized how valuable are many areas along the Hunter River and its tributaries.

### III. THE SITUATION—*Denudation*.

Coming to first principles, the beginning of streams and floods with which we are concerned is:—1. Rain falls more or less on the land. 2. Some sinks into the ground. 3. The balance drains away.

Thus a single paddock may be an object lesson in regard to forces at work in the whole of New South Wales, as I will endeavour to show presently. I shall seek to prove that our treatment of paddocks affords an illustration of the truth of the ancient saying to the effect that—

"Every act of man is the forerunner of a chain of consequences of which no one can foresee the end."

The natural forests on the rounded steep hills of the Upper Hunter have in many cases been destroyed, and the sheep and cattle tracks are everywhere in evidence, even in the steepest places. At the present time (May), these dry and dusty hills (near the source) are a pitiful sight, brown, vegetationless (apparently) although the sheep and stock looked well considering the season.

The innumerable sheep tracks are accentuated, and the ground everywhere is pulverised by the feet of the sheep wandering after the scanty herbage. When the rain falls much of this pulverised soil, carrying with it grass plants (latent) and seed of grasses and various forage plants must be washed into the creeks and again into the Hunter,



which becomes discoloured. As the country is nearly all rung it is to be hoped that many of these seeds will be arrested by the fallen timber.

As we proceed towards the hills from the water-courses, we come to the clay and sandy land and to the masses of undecomposed basalt, which have no manurial value but are a potentiality for future ages.

The poorer uplands can sometimes only be profitably used in conjunction with the rich flats on which they abut. This is clearly brought out in the evidence<sup>1</sup> in regard to the proposal of the late Mr. Price, to dam the Hunter below Denman. In fact, if we loose our flats, large additional areas will be thrown out of occupation.

#### *The Outlook Serious.*

My view is that it is only a matter of a brief historical period when unless preventive steps are taken, these rich river and creek flats will find their way into the Pacific Ocean. Some people, including men of great experience and careful thinkers, are, however, of a different opinion. They view the erosion with more or less equanimity, considering that what is taken off one bank is deposited on the other. Of course erosion is going on all over Australia, and to what extent compensating influences are at work is a question for geologists, but I believe the amount of loss far exceeds the gain.

I do not like the *laissez faire* argument as applied to the Hunter. It seems an argument analogous to that because there will always be evil in the world, efforts for the betterment of man's condition should be abandoned. As a matter of fact man's existence in the world is dependent on his maintaining an incessant warfare against what are called "the forces of Nature." As regards the particular case

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<sup>1</sup> "Hunter River Floods Prevention," Minutes of Evidence, Parl. Stand. Committee Public Works. Questions 1128, 1385, etc., 1901.



now under consideration, it is of course, a matter as to how far expenditure of effort and money are justified by the results they secure.

Let us not act as if we were content simply for the agricultural flats to last our time and then "Après nous le déluge." Like the nuggets of gold, and the forest monarchs (now sadly diminishing) we convert into timber, human agency has done nothing to produce them. Let us not deal with these rich flats simply as if they are capital to be got rid of in a brief period, but rather let us act in the capacity of faithful trustees, realizing that maintenance of the property is expenditure that must be incurred, and that it is vital to the very existence of the property.

#### IV. INTELLIGENT CONTROL OF RINGBARKING.

Going back to ultimate beginnings, to the creeklets, the source of all the troubles is the indiscriminate ringbarking and cutting down of vegetation by individual owners. The ringing or felling of trees in paddocks is of course necessary, but the requirements of the natural drainage seem not to be considered. The consequence is that in the dry creeks rifts appear, which gradually widen and carry soil, often the best soil, into the creeks and so on *ad infinitum*. The remedy lies in the intelligent control of ringbarking. Where there is an even contour of the land the operation is usually safe enough, but directly the land shows widening depressions that may carry water to lower levels, then operations should be undertaken with caution, since the water goes along the line of least resistance. In every paddock there is a getaway for the water, or if not, the water will make one. This getaway is the weak point of the paddock or other tract of country, but very often it receives no special notice or consideration. The trouble is accentuated in rich lands simply because of the finer texture or friability of such soils.



*The State of New South Wales is mainly made up of paddocks!* The paddock is the unit in considering the effects of erosion. Much of the mischief has already been done, but intelligent conservation of existing and future trees has vast possibilities for good. It ought to be made penal to ringbark up to a certain distance from a water-course, or to cut down a River Oak on any of the rivers (water-courses), except under a special license only to be obtained after due enquiry. The reason of the suggestions is because improper ringing or felling affects the riparian owner lower down, and he has quite enough difficulties to contend with which are beyond human control, to be victimised by the ignorant act of his fellow man higher up the stream. I could give an instance where a man cut down river oaks to make culverts; the river oak timber is now perished, and if he had gone but a few yards away he could have got almost imperishable ironbark. He now has to repair his culvert, but his river oaks are gone, his banks are falling away where he removed them, and a larger culvert is now required. In the case of a casual labourer this would have been termed living from hand to mouth. In the present instance it is miserable expediency and opportunism unworthy of thinking men. If the result of acts like these would alone affect the doer, we could view the matter with complacency.

a. *Shelter for Stock should be adequate.*—Shelter for stock is necessary; a few acres of trees should be left and not an odd tree or two which die out. The ruthless cutting down or sapping of trees has its basis in self-interest. A man desires to get the fullest advantage out of his land, and until it comes home to him that he is acting against his own interest in not conserving sufficient trees he will blunder along. In my view the advantage of leaving adequate shelter for stock is so obvious as not to be arguable.



b. *Danger of cutting trees too near the water-courses.*  
—All over the State people have made a mistake in sapping too near the rivers and water-courses. The dry, dead timber at the edge of the water-course no longer holds the banks for the reason that their roots have shrivelled and decayed and have no gripping power. Then the tree gets top heavy and breaks down the banks, and the second chapter of mischief starts.

The innumerable creeks will doubtless require to be dealt with in any effective remedy for the mitigation of floods. There is evidence everywhere of broadening streams, of banks breaking down and good soil washed away. Apple (*Angophora intermedia*), and River Oak (*Casuarina Cunninghamiana*), doubtless filled these flats, and they have been removed in order to cultivate the rich land to the fullest extent. The denudation is going on in geometrical progression. There are farmers even in a small valley like that of the Page near Murrurundi, who have lost as much as 50 acres through breaking down of banks.

What we see in the small creeks is repeated in the big rivers, so this is not a local matter merely as regards the little creeks. With friable banks every fresh carries down soil to the lower levels, and the stronger the current of course the greater the debris. This tends to work destruction at the lower levels. By all means therefore let us encourage people to prevent the erosion of the land higher up. It is not only that land is lost by erosion, but the land becomes a motive power to destroy property lower down. Much of the silt that people complacently see deposited on their ground is of course the soil of some unfortunate cultivator.

The matter might settle itself eventually by there being no more friable material to be washed away from the upper lands. If one could estimate the percentage of "flats"



area which has disappeared since the advent of the white man on some of the Upper Hunter streams I think the result would be startling.

#### V. DEVIATION OF ROADS.

The annual cost to the Roads Department of deviations necessitated by washaways and repairs necessary by washaways, must be very considerable, and having made special enquiries, I find that many of these washaways are the direct result of the destruction by private owners of trees along the getaways for water. If the cost to the Roads Department and to private citizens of road deviations, (with culverts, etc.) necessary through the washing away of the banks of rivers and creeks in the Hunter Valley, were available, I think it would surprise a good many people.

If the Public Works Department were to select say 100 definite places, on rivers, creeks, and furrows in cleared land (what I might term "incipient creeks") and photograph them every year, for say 5 or 10 years, the results would be of the highest educational value. They would be of value to the whole State, for the phenomena of aqueous denudation are in operation everywhere, although the results may not be, in most places, so disastrous as on the Hunter.

#### VI. FALLING IN OF BANKS.

These friable rich soil banks of the Hunter and some of its tributaries fall to some extent wet or dry. In dry weather they crack and tumble into the bed of the stream because of their lack of cohesion. In wet weather the rain soaks them, expansion takes place, cohesion again fails and the result is the same. These banks are, in fact, in a condition of unstable equilibrium.

#### VII. FLOODS AND WEEDS.

Another aspect of floods often lost sight of is the havoc committed in the lower lands by the transmission of weed



seeds and plants to lower levels, *e.g.*, Nut Grass (*Cyperus rotundus*), Yellow or Prickly Poppy (*Argemone mexicana*), Yellow Indigo (*Cassia* spp.), Bathurst Burr (*Xanthium spinosum*), Yellow Thistle (*Kentrophyllum lanatum*), Chinese Thistle (*Centaurea calcitrapa*) and other thistles and pests of various kinds. The undisturbed propagation of weeds in the bed of an upper creek thus means loss to any rich lands on a lower level. Therefore, although for engineering purposes the consensus of opinion is to work from Newcastle, my view as regards weeds prevention is to begin as high up the Hunter and its tributaries as possible. They not only float the seeds down, but nice rich silt to give the weed-plants a fair start in life.

#### VIII. SOME MISCELLANEOUS FACTORS IN EROSION.

a. *Boulders*.—The small stones and boulders in the bed of a stream are set in motion by floods, and forming eddies etc., grind down the banks. Good rich basaltic land is very fine grained, and washes away readily. The stones which are always found in it more or less help to break it away. Sometimes they form masses of considerable weight. The black soil everywhere rests on a bed of gravel. The water gets underneath and through the black soil, these gravel-stones facilitating the circulation of the water and the disintegration of the superimposed soil.

b. *Dead trees*.—The dead trees and branches felled for stock, unless they are dry enough for burning before the floods come, do much damage. So many River Oaks (and other trees) have been cut down during the present drought, that if a flood comes soon, enormous damage will be done through these dead trees tearing down the creeks and rivers. Dead timber of course threatens the bridges and also churns up the banks and works destruction. The courses of creeks are so irregular and the water comes down so suddenly that a stream may become a succession of grinding whirlpools.



c. *Stock*.—I desire to emphasise the damage caused by the trampling of horses and cattle, and by the nibbling and eating out of all vegetation in drought seasons such as the present. Let each landowner have his special crossing places for cattle, such places to be so arranged and prepared that the minimum damage of banks may be secured. See page 119.

#### IX. REMEDIAL AND PREVENTIVE MEASURES.

a. *Control of Ringbarking* (see page 112.)

b. *Fencing*.—Let me insist upon the judicious fencing of banks to protect their edges from stock and other traffic. I look upon this as one of the most important factors in preventing the erosion of the banks of the Hunter.

c. *Embankments*.—At present, owners of houses and shops and farmers are put to an increasing expense in protecting their properties by means of stone, pile and paling embankments, but in many cases the methods they are adopting are those of Mrs. Partington sweeping back the ocean, for the floods get at the back of their fortifications, and the last stage is worse than the first. In many cases the owners have large areas of additional land and do not bother about the problems concerned in the erosion of river banks. The probability is that if a man had only 40 acres and he lost 10 by a washaway, he would become alarmed, while a large landowner might treat the matter with comparative indifference.

What we see in West Maitland,—houses perched on crumbling banks and left more or less stranded,—we see on a smaller scale, *e.g.*, at Murrurundi on the Page River and in many other towns and villages on smaller creeks. If the welfare of West Maitland were alone at stake, then it might be worth while to resume the town and to sell the site for farms. Of course no other place is so seriously affected by the floods, but it would be inequitable to tax



the whole State for the sake of one town. What really is at stake is the rich soil along the whole course of the river and we should do all we can to prevent this marrow of the country from being wasted.

d. *Chamfering the banks.*—I would recommend that the soft banks be chamfered in some places. Where soft banks overhang, as we see in many places, they fall over and tear away enormous quantities of soil. One sees the remains of trees in many of these banks, and they do damage in precisely the same way as do the imbedded boulders already referred to.

e. *Planting and conservation.*—It appears to be very necessary to educate the people not to destroy timber and other vegetation on the banks and in the beds of creeks, and in certain places to proceed with replanting. It is quite true that replanting may in many cases mean the utilization of good land; it is equally true that if remedial measures be not proceeded with there will eventually be no good land left to plant on at all. Planting close to the edge is, I reiterate, a mistake, and arises from a natural desire to make the most of the land, to cultivate as much as possible for crops or grass. But trees and other plants placed too near the edge of a friable bank may be a source of danger and not a real protection, since they may act as a lever to break down the banks.

1. *Natural bank protectors.*—Let us observe the interlacing and ramification of the roots of trees in good soil (such as these flats and river banks). It is very extensive and their mechanical action in arresting washaways is obvious. One can see evidence that the banks of the Upper Hunter streams were much more lined with trees than at present. In many parts of the Hunter and its tributaries one sees large river oaks (many of them past their prime) leaving no descendants to continue their work of bank pre-



servation. The young seedlings are palatable to stock and hence they are eaten out if they have free access to them. This points to the necessary precaution that stock should not have unfettered access to the bed of a stream, as if it were a public highway. The seedling oaks should be carefully conserved until they are out of reach of stock. Great numbers of river oaks have been cut down this year for fodder alone.

One lays especial stress on the value of the river oak for purposes of bank protection, for the reason that it has for ages been the natural bank protector of these streams, and has become largely adapted to its environment. At the same time the acquisition of these lands by the white man and his method of dealing with the banks and adjacent country, constitutes a marked change in the conditions, and it may be that other trees are even better than the river oak for the purposes of bank conservation. River oaks have not a large tap-root; they have rather flat, spreading roots which penetrate the rich soil and silt on the bed of gravel already alluded to. When this gravel becomes bared, as it does in so many places, the river oak heels over and falls into the stream just as a boulder does.

2. *Other bank-protectors (exotic).*—Here and there one finds that plants other than river oaks have been utilized to protect the banks. Willows are the favourites, and I think rightly so. They grow naturally on the banks of streams, and during the winter months propagate naturally or artificially by cuttings very readily. Thus a flood which breaks off branches is the means of establishing other trees lower down. Stakes of willow up to six inches in diameter may be driven into the banks near the water, and in an ordinary season may be relied upon to flourish. At Segenhoe there is about a quarter of a mile of *Nicotiana glauca*, a South American weed, under the steep bank, which has



great promise as a protector of the banks. It forms a dense scrub and prefers drier situations than willows. On the Upper Hunter the common Passion vine has been found useful, in connection with willows, as a bank protector. Doubtless other riparian owners pin their faith more or less on other plants.

My view is that on the Upper Hunter the main bank-protectors should be trees, on the Middle Hunter small trees or scrub, and on the Lower Hunter, where the banks are usually low and friable, I would recommend creeping shrubs, and grasses, and other plants with underground rhizomes. I therefore make the following suggestions of readily available plants for the districts stated.

3. *Plants recommended for Upper, Middle, and Lower Hunter.*—A. List of trees recommended for the banks of the Upper Hunter:

1. *Casuarina Cunninghamiana*, Miq. The "River Oak," which has been referred to in the body of this paper. It may form a very large tree.
2. *Angophora intermedia*, DC. and *A. subvelutina*, F.v.M. These are rough-barked "Apple-trees." They attain a large size on the flats liable to inundation. Natives of Eastern Australia.
3. *Podocarpus elata*, R. Br. The "She, Brown or Berry Pine" which flourishes best on the banks of some of our rivers.
4. *Melia Azedarach*, Linn. The "White Cedar." One of our few deciduous trees. It is a native also of Asia. It grows readily from seed, which it produces abundantly. While this grows readily on river banks and among débris it will flourish on the drier mountain sides where it may be necessary to develop a rapid forest growth.



5. *Tristania conferta*, R. Br. The "Brush or Bastard Box," which requires a good depth of moist soil for its full development. It is perhaps better known under its nursery name of "Lophostemon."

The following are exotic trees :—

6. *Acer negundo*, Linn. The "Box Elder" of the United States, a deciduous Maple which affords an excellent summer shade.
7. *Ailanthus glandulosa*, Linn. A native of Asia which has several merits. Goats and other animals do not enjoy browsing upon it. Not only will it grow on the banks of rivers and bind them with its suckering roots, but it is one of the few that will flourish in the almost pure sand of the coast and of the Hunter River estuary.
8. *Platanus orientalis*, Linn. The "Oriental Plane," native of Europe and Asia. A noble tree which can be propagated by cuttings or seeds.
9. *Populus angulata*, Ait. The "Water Poplar" of the Eastern United States, so called because of the damp situations in which it flourishes.
10. *Robinia pseud-acacia*, Linn. A native of the United States, and commonly known as "Acacia." It is remarkably tolerant to heat and cold, lack of moisture and plenty of it, and to poverty of soil. It will bind shifting sand.
11. *Salix babylonica*, Linn. The common or "Weeping Willow," which is perhaps the best of all trees for consolidating river banks. Its roots form a net-work which bind soil, it will grow by the very brink of a stream and its pendulous branches that are broken down by the floods and winds take root lower down the stream.
12. *Taxodium distichum*, Rich. The "Virginian or Swamp Cypress," which in its native country flourishes in



sour, undrained swamps. It is less tolerant in cultivation, but it flourishes on the banks of waters where its roots can have full play.

13. *Ulmus campestris*, Linn. The common "Elm," which is well worthy of introduction in the Upper Hunter Valley as a soil-binder.

B. List of small shrubs or scrub recommended for the banks of the Middle Hunter :—

1. *Buddleia madagascariensis*, Lam. A well known plant which forms a rapid growing, tall shrubby mass. It is readily propagated by cuttings.
2. *Commersonia Fraseri*, J. Gay. A tall native shrub which naturally grows on the banks of water-courses.
3. *Cudrania javanensis*, Trécul. The "Cockspur Thorn," also a native shrub which forms an impenetrable mass of dense growth well calculated to bind soil and prevent further destruction. Propagated by cuttings.
4. *Duranta Plumieri*, Jacq. A tall growing shrub from the West Indies which forms dense masses. Readily propagated by cuttings.
5. *Hymenanthera dentata*, R. Br. This is a tall native shrub which forms large masses in good soil in many places in our coast districts. In the Upper Hunter district it flourishes already in many parts, Moonan Flat, for example.
6. *Ligustrum* spp. The "Privets," of which there are several species and varieties. They are all more or less soil binders and can be readily propagated by cuttings.
7. *Lycium barbarum*, Linn. A "Box thorn" which is a well known hedge-plant. It is not particular as to soil or situation.



8. *Olea europea*, Linn. The common "Olive." It likes good soil, and although it prefers proximity to the sea, there are many places in the Middle Hunter where it will flourish. The wild Olive which yields but a poor fruit could be planted, but I would like to see truncheons planted of the best pickling and oil-yielding Olives obtainable.
9. *Polygala myrtifolia*, Linn. A shrub of moderate size from the Cape. Not of special merit.
10. *Salix aurea*, Salisb. (a variety of the Huntingdon Willow *S. alba*, Linn.). The "Golden Willow." Most willows are valuable for the purpose under reference.
11. *Tamarix gallica*, Linn. The "Tamarisk." A native of Europe and Asia, which is very tolerant as regards soil and situation. It grows readily from cuttings and is a well tested soil-binder, even of sand.

C. List of grasses, creeping shrubs, etc., recommended for the banks of the Lower Hunter:—

1. *Cynodon dactylon*, Pers. The "Doub" or common "Couch-grass" of Eastern Australia. It is an excellent soil or sand-binder, so well known as not to require extended notice at this place. This and the five grasses which follow form a dense turf.
2. *Panicum plicatum*, Lam. This is a broad leaved grass from Southern Asia, which forms a coarse turf when eaten down.
3. *Paspalum dilatatum*, Poiret. During the last few years this American grass has come into great prominence for grazing for dairy cattle. It and several other *Paspalums* are excellent sand-binders and should be encouraged on the Lower Hunter.
4. *Paspalum distichum*, Linn. "Silt grass" or "Water Couch." A native grass and a good soil-binder in moist situations.



5. *Stenotaphrum americanum*, Schrank. The well known "Buffalo Grass" of New South Wales. This is a native of America. The nearer the sea the more it flourishes and it will stand droughty conditions which will destroy many grasses.
6. *Andropogon Schimperi*, Hochst. A tussock grass from Abyssinia, which stools readily and which promises to be a valuable grass for New South Wales. I believe it will prove to be a valuable soil-binder for the Lower Hunter.
7. *Elymus arenarius*, Linn. The "Sea Lyme Grass" of Northern Europe and Asia. It and the Marram Grass are excellent sand-binders.
8. *Cortaderia argentea*, Stapf. (*Gynerium argenteum*, Nees.). The well known "Pampas Grass" of South America, which grows in large tussocks.
9. *Imperata arundinacea*, Cyr., the "Blady Grass" of Eastern Australia which is a most effectual soil-binder, though not like most of the grasses recommended, a useful fodder plant in addition.
10. *Psamma arenaria*, R. et S. The well known Marram grass of North Europe and North America. Its value as a sand-binder in Victoria and New South Wales has now been proved beyond question.
11. *Small Bamboos* of any species should be tried on the Lower Hunter. They spread from the roots and their tough stems are very tenacious of life.
12. *Arundinaria falcata*, Nees. One of the smaller Himalayan Bamboos recommended for soil-binding.
13. *Arundinella nepalense*, Trin. A New South Wales grass worthy of further experiment for the purpose indicated.



14. *Arundo donax*, Linn. This handsome "Bamboo Reed" is now well acclimatised in New South Wales and flourishes in moist situations. It is a good soil-binder.
15. *Arundo phragmites*, Linn., (*Phragmites communis*, Trin.) The "Bamboo Reed" of New South Wales and many other parts of the world. It grows naturally along the margins of lagoons and water-courses and its growth should be encouraged on the Lower Hunter. I believe it to be the "Small cane" referred to in the enclosed letter to me by Mr. Charles Ledger the well known South American traveller of "Cinchona Ledgeriana" fame:—"The valleys of the Sama and Locumba are somewhat like those of the Hunter. In the first (Sama) is situated 30 miles of sandy plains near Tacna (Peru). During Dec., Jan., Feb., and March (or rainy season) its river, increased by the rains in the interior, rushes down its course from W. to E. with great force, undermining the banks on both sides, carrying away in that manner acres of soil where the banks are not protected by rows of *small cane* growing to a height of 10 to 12 feet. This small cane breaks the force of the rushing waters, and thus the river overflows its banks without carrying away the soil as formerly. In the same way the valley of Locumba is protected, indeed all valleys so situated in Peru."
16. *Bambusa gracilis*, Hort. and *B. nigra*, Lodd. Two more small bamboos that I can recommend as bank-protectors.
17. *Cyperus alternifolius*, Linn. An ornamental sedge from Madagascar which flourishes in damp situations.
18. *Escallonia rubra*, Pers. A small shrub from Chili which might be tried as a bank-protector.



19. *Mesembryanthemum æquilaterale*, Haw. The well known "Pig's Face" of our coasts. A succulent leaved plant which is useful as a sand-binder where there is not much traffic over the plants themselves.
20. *Phormium tenax*, Forst. and *P. Colensoi*, Hook. f. Two species of the well known New Zealand Flax, which possesses considerable merit as bank-protectors.
21. *Plumbago capensis*, Thunb. A well known shrub which forms a dense bushy growth.
22. *Rhagodia hastata*, R. Br. and *R. Billardieri*, R. Br. Two of our salt-bushes that may be recommended as sand-binders in brackish or sea side situations.
23. *Rubia tinctorum*, Linn. The "Madder" of Europe, which forms a low, smothering growth. It is worthy of a trial as a soil protector.
24. *Lippia nodiflora*, Linn. A low-growing plant which forms a mat on nearly pure sand. It belongs to the Verbenaceae family and has been found on the coast at Tuggerah Lakes and further north.

4. *Nurseries*.—Each land-owner should have his own nursery of trees, shrubs and etc. The River Oaks yield abundance of seed and they are easy to rear, and the raising of trees and other plants is not beyond the power of any intelligent citizen. If our people would only carefully consider the question, it would be better for themselves, better for gardeners and nurserymen, and better for the country generally. No one doubts the capabilities of our people as eradicators of vegetation; it should be brought home to them that it is to their advantage to act judiciously in a contrary direction.

#### X. SUMMARY OF PROPOSALS.

I will now summarise my proposals for the mitigation of floods in the Hunter. They are not sensational, but they



are all practical, and if they be given a fair trial I think that it will be found that they are based on sound principles.

1. Intelligent control of ringbarking or felling. This is the beginning of all things, the attempt to get at the little rifts in the ground-surface that have such mighty consequences.
2. Repair of little incipient rivulets by gradual replanting or placement of obstructions (logs etc.).
3. Planting of Willows and other trees, shrubs, grasses etc.
4. Chamfering of the banks.
5. Fencing of banks.
6. Burning as much as possible of the dead timber and branches to prevent their finding their way into the water-courses and scouring the banks. There is an especial abundance of dead timber after a drought.

#### APPENDIX I.—*Mountain torrents in Europe.*

I add a statement from one of the best modern works on forestry<sup>1</sup> in regard to flood mitigation in Europe. The mountain torrents are, as a rule, different in character from the Hunter River and some of the methods in vogue in Europe would be impracticable here on account of the expense. I repeat my advice "to meet the danger at its source." Let us guard against undue erosion by the creek-lets and creeks, and the big river will largely take care of itself. I am only referring to floods which have their origin in the Upper Hunter.

"Private agency can usually do nothing or little to prevent floods. The action of the State is indispensable, as the cost of the erection and maintenance of the works necessary to secure this object is quite out of proportion to the value of the property on which they must be erected,

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<sup>1</sup> Schlich's "Manual of Forestry," Vol. iv., page 501.



and the work of fixing the beds of mountain torrents and hill-sides in process of denudation must be carried out over a large area. The most effective measures depend on the management of the collecting areas of dangerous water-courses, *the main principle being to meet the danger at its source.* . . . (the italics are mine, J. H. M.)

“Serious and successful action however, is being taken in France, Switzerland and the Tyrol, to counteract the causes of floods. The chief rules to be followed are:—  
(a) Revetment of torrents and their feeders. By this means earth, gravel, and boulders are retained in the mountains. Works of the following nature should be designed in accordance with the nature of the locality, the characters of the torrents, the area of the collecting ground, and the funds available:—

1. Barricades of trees with their entire crowns thrown across the torrents.
2. Wattle fences across the bed of torrents.
3. Dams made of fascines or masonry, to cause the deposition of coarse material, to be constructed across the torrents at suitable distances.
4. Paving the bed of the torrent.
5. Wattle fencing on revetments along the banks of torrents to moderate the cutting action of the water.”

#### APPENDIX II.—*Lessons to be learnt from some European Rivers.*

I now give other European instances of conditions more closely paralled to those of the Hunter River. The rivers Volga, Garonne, and Loire afford special lessons to us, and since the injudicious felling of trees is attended by evil consequences the wide world over, we should lay the lessons to heart in New South Wales. As I propose to deal with the subject of deforestation more fully on another occasion,



I must dismiss it with these cursory and wholly inadequate references.

“The Alps and the Pyrenees, exposed to the same treatment, have been similarly affected. The deforestation paralyses the development of the pastoral industries in these regions by lowering the limits of forest vegetation. The valleys are ravaged by a devastating erosion. Entire mountains slide down slowly, carrying with them the pastoral villages which they bear on their surface, accumulating ruin and disaster.”<sup>1</sup>

“These processes do not affect the mountain alone. For, by the very fact of this deforestation, the rich plains of the Garonne and the Loire are subjected to disastrous floods which make the fate of agriculture in these regions very precarious. This state of things has not failed to arouse apprehension among the inhabitants. Researches with regard to the question have shown that the devastating character of these inundations is due to the destruction of the forests which formerly covered the Central Plateau and the Pyrenees. The waters, no longer absorbed and regulated by the forest vegetation, flow away on the surface in enormous and sudden waves. The débris thus carried away in vast quantities contributes to the formation of barriers and gives to the waters their destructive power.

“But the danger does not cease there. The navigation of the great rivers gradually silted up by this waste from the mountains is rendered very difficult. So much is this the case that even Russia, a country so uniformly flat, is threatened in the use of its great water-way, the Volga. The investigations ordered by the Russian Government have demonstrated that this is the result of the drainage

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<sup>1</sup> Demontez, “*Traite pratique du reboisement etc.*” 2nd edition 1882. Also J. Croumbie Brown, *op. cit.*



of the marshes and the deforestation of the low hills which give birth to the river.”<sup>1</sup>

APPENDIX III.—*An instance of denudation in the United States.*

I will conclude with a graphic account by Mr. McGee of the destruction going on at present to form the “bad lands” of the State of Mississippi. I do not think that truth has been sacrificed to fine writing and do feel that what has been taking place in the Mississippi Valley has its counterpart in the Hunter Valley, New South Wales. The quotation is from Bulletin No. 7 of the Forestry Division of the U. S. Department of Agriculture:

“With the moral revolution of the early sixties came an industrial evolution; the planter was impoverished, his sons were slain, his slaves were liberated, and he was fain either to vacate the plantation or greatly to restrict his operations. So the cultivated acres were abandoned by thousands. Then the hills, no longer protected by the forest foliage, no longer bound by the forest roots, no longer guarded by the balk and brush dam of the careful overseer, were attacked by rain-drops and rain-born rivulets and gullied and channeled in all directions; each streamlet reached a hundred arms into the hills, each arm grasped with a hundred fingers a hundred shreds of soil, and as each shred was torn away the slope was steeped and the theft of the next storm made easier.

“So, storm by storm and year by year, the old fields were invaded by gullies, gorges, ravines, and gulches, ever increasing in width and depth until whole hill sides were carved away, until the soil of a thousand year’s growth melted into the streams, until the fair acres, of ante-bellum days were converted by hundreds into bad lands, desolate and dreary as those of the Dakotas. Over much of the upland the traveller is never out of sight of glaring sand wastes where once were fruitful fields; his way lies sometimes in, sometimes between gullies and gorges—the “Gulfs” of the blacks whose superstition they arouse, sometimes shadowed by foliage, but oftener exposed to the glare of the sun reflected from barren sands. Here the road winds through a gorge so steep that the sunlight scarcely enters, there it traverses a narrow crest of earth between chasms scores of feet deep in which he might be plunged by a single misstep. When the shower comes he may see the roadway rendered impassable, even

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<sup>1</sup> A. Woeikof. “De l’Influence de l’homme sur la terre.” *Ann. de Geogr.* X., 1901. (Quoted by Marcel Hardy in *The Scottish Geogr. Magazine*, May 1902.



obliterated, within a few minutes; always sees the falling waters accumulate as viscid mud torrents of brown or red, while the myriad miniature pinnacles and defiles before him are transformed by the beating raindrops and rushing rills so completely that when the sun shines again he may not recognize the nearer landscape.

“This destruction is not confined to a single field nor to a single region, but extends over much of the upland. While the actual acreage of soil thus destroyed has not been measured, the traveller through the region on horseback daily sees thousands or tens of thousands of formerly fertile acres now barren sands; and it is probably within the truth to estimate that 10% of upland Mississippi has been so far converted into bad lands as to be practically ruined for agriculture under existing commercial conditions, and that the annual loss in real estate exceeds the revenues from all sources. And all this havoc has been wrought within a quarter of a century. The processes, too, are cumulative; each year's rate of destruction is higher than the last.

“The transformation of the fertile hills into sand wastes is not the sole injury. The sandy soil is carried into the vallies to bury the fields, invade the roadways and convert the formerly rich bottoms lands into treacherous quick sands when wet, blistering deserts when dry, hundreds of thousands of acres have been destroyed since the gulying of the hills a quarter of a century ago. Moreover, in much of the upland the loss, is not alone that of the soil, *i.e.*, the humus representing the constructive product of water-work and plant work of thousands of years, the mantle of brown loam, most excellent of soil stuffs, is cut through and carried away by corrosion and sapping leaving in its stead the inferior soil stuff of the Lafayette formation. In such cases the destruction is irremediable by human craft—the fine loam once removed can never be restored. The area from which this loam is already gone is appalling, and the rate of loss is increasing in geometric proportion.”

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