A Study of Plant Species Suitable for Riverside-Riparian Areas

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Abstract

Transition zones between land and water environments are narrow strips of land called Riparian Areas having a distinct ecosystem. Ecologically these areas hold great importance in regulating natural cycles between terrestrial and aquatic environments. However these zones are plagued with problems stemming from natural occurrences and those coming from man-made actions.

Specific plant species are looked into and analyzed against given criteria and then tabulated to assess each plant's usefulness against specific needs / problems of riverside-riparian areas. This practice in rating plants creates a system whereby species are applied correctly and with reason.

Ecology and Environmental Conditions

Riparian areas in general are transition zones. They are ecosystems between land and water environments. Also, they are narrow strips of land located along streams, lakes, potholes and springs. In this light, studying each and every area covered by the definition would be a lengthy task. Therefore, this study has been narrowed down to focus on the Riverside-Riparian areas.

Riverside-Riparian areas hold importance for river channels. They absorb and slow down river flow and it is in these areas that the food and nutrient cycles of the riverine and riverside-riparian ecosystems interact. Other importance of such areas include improving water quality, helping wildlife conservation and creating visual amenity and recreation.

The flora typical of such areas are those that can survive wet to near wet conditions. Usually, these riverside-riparian areas are lush with vegetation. The wildlife found consists mostly of aquatic wildlife, waterfowl and avifauna.

Problems of Riverside-Riparian Areas

The main problem in such areas is erosion. It may be a common as well as an inevitable force in nature but with certain techniques and practices erosion can be slowed down and controlled if not stopped. There is also lack of vegetation as well as the presence of herbicides and other forms of pollution. Finally there is Man who basically sums up all the above mentioned problems and is the culprit in the presence of erosion, in lack of vegetation and the presence of pollutants.

Plant Palette

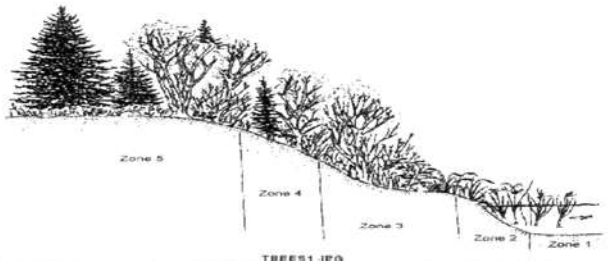

Figure 1 - Planting Zones. Copyright c 1996 Alaska Dept. of Fish and Game. All rights reserved

The choice of plants will depend largely on the plant's adaptability to the site, its soil holding qualities and its ability to control pollution from terrestrial environments (phytoremediation). The tree and shrub species listed below are, by no means, the only available species. Several of them were actually observed in the field. The typical riverside-riparian section is divided into these zones of wetness:

Zone 1 = Hydric soils – relatively slow flowing open water along streams or lakes

Zone 2 = Hydric-Mesic soils – fluctuating water levels subject to boat or wind driven waves

Zone 3 = Hydric-Mesic soils – floodway terrace

Zone 4 = Mesic soils – seasonally variable moisture regimes

Zone 5 = Mesic Xeric soils – Upland benches

Plant Species

Trees

Figure 2 - Bambusa vulgaris, Bamboo, Zone 3 – Zone 5 = Stems tall, 1-2" in diameter, spineless, internodes bright yellow, striped with green. China, Japan. Numerous species and varieties cultivated in the Philippines.

Figure 3 - Callistemon viminalis, *Weeping Bottlebrush*, Zone 2 – Zone 5 = Shrub to small tree, long slender and drooping branches to 5 m. tall. Leaves narrow lanceolate. Flowers bright red.

Figure 4 - Eucalyptus globulus, Blue gum tree, Zone 5 = Tall tree to 15 m. or more. Trunk and branches with barks flaking into thin long strips. Leaves are lanceolate dark green with aromatic mint scent.

Figure 5 - Ficus benjamina, *Balete*, Zone 2 – Zone 5 = Straggling fig with milky sap, assuming tree form to 15 m or more. Leaves are alternate oblong ovate. Fruit is solitary dark purple.

Figure 6 - Leucaena leucocephala, *Ipil-Ipil*, Zone 5 = Shrub to small tree to 5 m tall. Leaves evenly bipinnate. Flowers are sessile, white in dense globose heads.

Figure 7 - Mangifera indica, Mango, Zone 4 – Zone 5 = Robust tree to 20 m. tall with wide spreading branches leaves are lanceolate, flowers are numerous and pinkish white, with edible fruits.

Figure 8 - Muntingia calabura, *Aratiles*, Zone 2 – Zone 5 = Tree to 10 m. tall with spreading branches. Leaves alternate, distichous oblong ovate to broad oblong. Flowers white and 2 cm in diameter. Fruits globose red fleshy and edible.

Figure 9 - Schizostachyum lima, *Bagakai*, Zone 3 – Zone 5 = Dense clump forming bamboo. Culm erect with drooping tip and reaches 7 m. tall. 2-4 cm. In diameter, rough hairy when young. Leaves are broad rough and green.

Figure 10 - Swietenia mahoganii, Mahogany, Zone 3 – Zone 5 = Medium sized tree to 20 m. tall. Leaves are deciduous alternate, pinnately compound and petioled. Flowers small and greenish yellow. Fruit is a barrel shaped woody capsule.

Figure 11- Terminalia catappa, *Talisay*, Zone 3 – Zone 5 = Medium sized tree to 8 m. tall. Branches spreading horizontally. Leaves broad round to oval. Fruit compressed and ellipsoid.

Shrubs

Figure 12 - Acorus calamus, *Lubigan*, Zone 1 – Zone 2 = Grasslike perennial herb, to 2 m. tall. Leaves are linear-tufted, equitant, with prominent midrib, and rise from stout, horizontal rhizome.

Acorus gramineus, N/A, Zone 1 – Zone 2 = On rocks and bed edges of small streams at low and medium altitudes.

Figure 13 - Cyperus alternifolius, *Umbrella plant*, Zone 1 – Zone 2 = Clustering perennial plant to 1.5 m. tall. Stems are cylindric ribbed smooth and green. Leaves linear radiating from the terminal point of stem.

Figure 14 - Monochoria hastata, N/A, Zone 2 – Zone 3 = In and along fresh water pools, on canal banks, on mudflats, along rivers, irrigation ditches.

Monochoria vaginalis, *Gabing uwak*, Zone 2 – Zone 3 = Fleshy semi aquatic annual herb to 50 cm. Tall Stem is basal and very short. Leaf blade shiny deep green. Flowers clustered and violet, fruit is a capsule.

Phragmites communis, *Tambo*, Zone 2 – Zone 3 = Found along wet to swampy conditions.

Typha angustifolia, *Cat tail*, Zone 1 – Zone 2 = Erect, perennial herb to 2 m. tall. Leaves flat, long linear and sheathing at the base. Flowers are small to 20 cm. Long and densely crowded in long spikes.

Vetiveria zizanioides, *Vetiver grass*, Zone 2 – Zone 5 = Tall, coarse, tufted perennial grass, to 2 m. tall with aromatic roots and leaves. Leaves numerous to 1 m. long Panicles are terminal erect, purplish or greenish.

Palms

Figure 15 - Palms - Livistona saribus, Tikal, Zone 3 = Solitary erect palm to 25 m. or taller. Leaves palmate large to 1.5m long, flowers are small and in clusters, fruits are globose and blue.

Nypa fruticans, Nipa, Zone 2 – Zone 3 = Gregarious palm growing in brackish swamps. Leaves are featherlike to 10 m. long, with stout petioles.

Climatological and Engineering Uses of Plants

This next section of the paper aims to look into each individual plant species and assess their usefulness as controls for climatic elements like rain, wind and sunlight. This section also aims to find the engineering capabilities of the mentioned plant species such as for soil erosion control.

The research for this section is based on ready reference regarding climatological and engineering uses of plants. This reference however, is based on temperate conditions. For climatological and engineering uses, there is a criterion that can be followed in assessing the capability of plant species. However, some of the criteria have to be deduced or manipulated from the given reference so as to fit the research at hand.

Each plant species was generally grouped into trees-palms and shrubs. Each plant within each group was then assessed according to the general criteria shown below. Trees and palms were assessed according to the criteria that best apply to them. Shrubs were also assessed according to applicable criteria.

General Criteria for Non-urban and Urban areas

The following were used for finding out the climatological uses of each plant species:

1. The plant is Deciduous or Evergreen or Sheds its leaves but not all at once.
2. The kind of shadow the species exhibits, whether it is fine (few to none light holes) or coarse (with extensive light holes)
3. The degree of solar radiation control if it intercepts, obstructs or reduces
4. The degree of wind control, if it is poor or good
5. The degree of precipitation control if it is poor, moderate or good
6. The degree of glare control if it is poor, moderate or good
7. The degree of temperature control if it is poor, good or not applicable

The following were used for finding out the engineering uses of each plant species:

1. The degree of soil erosion control if it is poor or good
2. The degree of wind erosion control if it is poor or good
3. The degree of sound absorption if it is poor or good
4. Ability to create "white noise" if it is poor or good
5. The ability for atmospheric purification if it is resistant, intermediate, sensitive or there is no research yet for this kind of plant
6. The ability for aquatic purification if it can or cannot or there is no research for the ability of this plant to purify water.

The following were used for finding out the aesthetic uses of each plant species.

1. Canopy form if it is rounded or globular, oval, conical or pyramidal, weeping or drooping, upright, spreading or horizontal and irregular
2. Shrub form same as above for canopy form
3. If the plant is flowering or not
4. What color the flower is
5. If the plant is fruiting or not
6. The season when the plant flowers

Each plant species was then grouped into trees and shrubs and investigated against criteria above. The tree species were investigated against climatological and engineering criteria that follow. Each criterion is then further explained as to the reason why they are used as such:

For Trees in Non-Urban Environment

1. Leaf shed behavior - knowing the shedding behavior of the plant gives us an idea of its effectivity to control wind, precipitation, sound and atmospheric purification.
2. Shadow exhibited - obviously the effectivity of the plant as a shading device is governed by the kind of shadow it projects.
3. Solar radiation control - knowing if the plant controls sunlight by intercepting it, obstructing it, reducing it or if it has poor solar control tells us the plant's effectivity to give shade.
4. Wind control - if the plant has characteristics for channeling wind then we can use this to create cooling movements of air/wind in an area.
5. Precipitation control - obviously the better the plant controls precipitation the better it is for people.
6. Soil erosion - if the plant is known to hold soil and has a good root system to do so then it is good for controlling erosion.
7. Wind erosion - the ability of the plant to control wind erosion is dependent on the same characteristics as those for wind control. Thus, if the plant can control wind then it can control its effect to erode loose soil. As well, air laden with dust particles approaching or hitting a wind break or plant barrier will tend to drop its load of particles.
8. Sound absorption - the characteristics of certain plants enable them to control sound. With this in mind, these particular plant species can be placed at or near the sound sources to minimize them as in highways and vehicular paths.

9. White noise - white noise is produced by the rustling and scratching together of leaves in wind. White noise can mask unwanted noise such as noise from factories or vehicular access ways.
10. Atmospheric purification - there are certain plant species that have the ability to absorb atmospheric pollutants like sulphur dioxide and nitrous oxide that come from vehicular emissions and factories. Placing these plants between people and the source of emission is a solution.
11. For aesthetic purposes, the shape of the canopy or the form it takes will be a good design element especially where we want an "effect" on our sites
12. If the tree flowers then that is a good addition to the overall aesthetic effects.
13. Knowing the color of the flowers of particular species is helpful in knowing where to put that plant and what other elements it can combine with.
14. If the plant is fruiting, since the site is a non-urban more natural environment, then its effects, i.e., dropping, is a welcome sight.
15. Knowing the season when the plant flowers is beneficial in terms of knowing when to expect and possibly what other species to combine it with so that there is at least a constant bloom of flowers and color.

For Trees in Urban Areas

1. Leaf shed behaviour - Obviously for cleaning purposes, the species to be selected have to be deciduous and/or large leafed. At least with a regular shedding period the maintenance task can be coordinated.
2. Shadow exhibited - same as for non-urban areas
3. Solar radiation control - same as for non-urban areas
4. Wind control - in urban areas the wind tunnel effect is sometimes harsh so the use of plants for wind control must be minimized.
5. Precipitation control - same as for non-urban areas
6. Soil erosion control - same as for non-urban areas
7. Wind erosion control - same as for non-urban areas
8. Sound absorption - same as for non-urban areas
9. White noise - same as for non-urban areas
10. Atmospheric purification - same as for non-urban areas
11. Canopy form - same as for non-urban areas
12. Flowering - same as for non-urban areas
13. Color of flowers - same as for non-urban areas
14. Fruiting - avoid, the fruit drops will become a problem for maintenance and people.
15. Flowering season - same as for non-urban areas

For Shrubs of Urban and Non-urban Areas

As well, the shrubs in the plant palette was investigated also under the following criteria:

1. Glare control - the structure as well as the height of the plant is beneficial in controlling glare especially glare coming from the water. With a closed dense structure glare is either lessened or stopped.
2. Temperature control - it is known that planted surfaces are cooler than surfaces that are exposed. Therefore placements of plants are beneficial in lowering the temperature of an area.
3. Soil erosion - same as above
4. Wind erosion - the wind velocity may be lower nearer to the ground, nevertheless the shrubs even though they are low in height can still effect some substantial control by holding the soil most especially if they are planted in groups.
5. Aquatic purification - most of the shrubs mentioned in the plant palette either thrive in moist to dry soil or wet to submerged soil. There are studies of these kinds of plants having the ability to intake aquatic pollutants, sewage etc into their system and absorbing. These plants would be beneficial in cleaning up the water.
6. Shrub form - the form can be created as in manicured landscapes or the natural form of the plant can be left to grow. In any case, the same principle for tree canopy form is followed in regards to letting the shrub take on its natural form.
7. Flowering - flowering shrubs are a welcome sight in otherwise monotonous urban color.
8. Color - same as for tree species
9. Flowering season - same as for tree species

Plant Rating System for Pedestrian Control

The shrubs were also investigated for their degree of usefulness as traffic control devices. Each plant was studied for its growth habit, the ultimate height, the spacing required and the plant's width.
The rating below is used in determining the effectiveness of the given plant species as traffic control devices for automobiles and motorbikes, bicycles and pedestrians. The given system referenced concentrated on shrubs as traffic control devices.

Criteria for Rating

Unique characteristics (C)

1. Single stem-no thorns-flexible branches
2. Single stem-no thorns-stiff branches
3. Multi stem-no thorns-flexible branches-open
4. Multi stem-no thorns-flexible branches-less open
   Multi stem-no thorns-stiff branches-open
5. Multi stem-no thorns-stiff branches-dense
   Single stem-thorns-flexible branches
6. Single stem-thorns-stiff branches
7. Multi stem-thorns-flexible branches-open
8. Multi stem-thorns-flexible-less open
   Multi stem-thorns-stiff branches-open
9. Multi stem-thorns-flexible-dense
   Multi stem-thorns-stiff-less open
10. Multi stem-thorns-stiff branches-dense

Spacing of Plant (S)

1. 30″ and wider
2. 27″-30″
3. 24″-27″
4. 21″-24″
5. 18″-21″
6. 15″-18″
7. 12″-15″
8. 9″-12″
9. 6″-9″
10. 6″ and narrower

Ultimate height of Plant (H)

1. 0-3″
2. 3-6″
3. 6″-12″
4. 12″-18″
5. 18″-24″
6. 24″-30″
7. 30″-3′
8. 3′-4′
9. 4′-5′
10. 5′ and higher

Plant width (W)

1. 6″
2. 9″
3. 12″
4. 18″
5. 2′
6. 3′
7. 4′
8. 6′
9. 8′
10. Wider than 8′

T-C number (traffic control)	Degree of effectiveness
4-10 pts.	minimum
10-20pts	average
20-30pts	good
30-40pts	excellent

Table 1 - degree of effectiveness

Balete (Ficus Benjamine)	Aratiles (Muntingia calabura)	Weeping Bottle Brush (Calistemon Viminalis)	
S	S	S	Leaf Shed Behavior D/E/S
Fine	Coarse	Fine	Shadow Fine/Course/Poor
Int.	Obs. Fil	Int.	Solar Radiation Control Int./Ref. Red/Obs. Fil/Poor
Good	Poor	Good	Wind Channeling Control Poor/Good
Mod.	Mod.	Poor	Precipitation Control Poor/ Moderate/ Good

Table 2 - Criteria for Climatological Use

Balete (Ficus Benjamine)	Aratiles (Muntingia calabura)	Weeping Bottle Brush (Calistemon Viminalis)	
Good	Good	Good	Soil Erosion Control Poor/Good
Good	Poor	Good	Wind Erosion Control Poor/Good
Poor	Poor	Poor	Sound Absorption Poor/Good
Poor	Poor	Poor	White Noise Poor/Good
Sensitive	No Research	No Research	Atmospheric Purification Resistant/ Intermediate/Sensitive /No Research

Table 3 - Criteria for Engineering Use

Balete (Ficus Benjamine)	Aratiles (Muntingia calabura)	Weeping Bottle Brush (Calistemon Viminalis)	
Irregular	Horizontal	Weeping	Canopy form Rounded/ Globular/ Oval/ Conical Pyramidal/ Weeping/ Drooping Upright/ Spreading/ Horizontal/ Irregular
No	Yes	Yes	Flowering Yes/No
	White	Bright Red	Color of Flower
Yes	Yes	Not Known	Fruiting Yes/No
	Not Known	Not Known	Season of Flowering

Table 4 - Criteria for Aesthetic Use

The following are some shrubs that are found in the plant palette for riverside-riparian areas with their corresponding points.

1. Acorus gramineus C – 4 multi stem-no thorns-flexible less open
   H – 10 5′ and higher
   S – 10 6″ and narrower
   W – 3 12″ width
   27 pts. Good degree of effectiveness

2. Vetiver grass C – 4
   H – 10
   S – 4
   W – 7
   25 pts. Good

3. Papyrus C – 4
   H – 8
   S – 5
   W – 3
   24 pts. Good

4. Cat tail C – 4
   H – 10
   S – 8
   W – 2
   24 pts. Good

Most of the shrubs here grow near the water's edge apart from the vetiver grass which can grow near water or farther away. These plants that grow near the water's' edge obviously would make poor vehicular traffic control devices by virtue of where they grow. The given points above show that these shrubs are good for traffic control, but to clarify, these shrubs would only be good for pedestrian traffic control near the water's' edge. They can be used as barriers to prevent people from going to or near the water.

These tables, with three plant species as example, are now the result of tallying up individual plant species against the above mentioned criteria. With such a system it becomes easier to see how to best use a particular plant species when it comes to controlling climatological elements, controlling engineering problems and when it comes to using these plants for aesthetics.

This is a typical section through a riverside riparian area along a portion of the Pasig River in Marikina. The section is divided into active (meaning there are more people in this area, more users) and unused-passive (less people) areas based on the observed current usage of that portion. We know what plants to use and with such a system we now know what zones they will grow in and how to use them thus we are able to better apply these plants on the site. The scenario of where the active and unused-passive areas can change however, is dependent on the users' liking. But nevertheless with such a system it doesn't matter where the active areas are or where the unused passive areas are located; it is still possible to apply the planting correctly.

For Active Areas
Combinations of tree species and shrub species that exhibit good degrees of climatological, engineering and aesthetic control

For Unused-Passive Areas
Combinations of tree species and possibly other shrubs that exhibit some or no degree of climatological, engineering and aesthetic control.

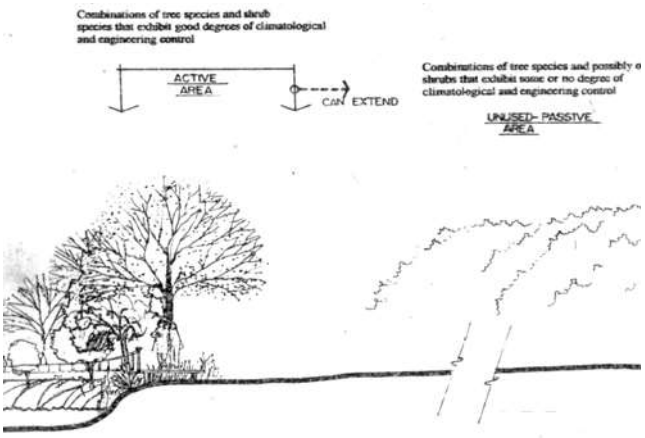

Figure 16 – Active Area vs. Passive Area

It will be noticed that plants as exemplified on the table above are not perfect. For example a plant may be appropriate by virtue of a certain criterion but may not be useful when it comes to another criterion. Therefore it becomes necessary to plant combinations of species so that one plant species lacking in one criterion can be compensated for by a species that fills in that lack. Where there are active areas this is where the system is applied as near best as possible, otherwise in the unused-passive areas the system can be applied to a lesser extent.

Design Guidelines

Given the information in the previous headings, there are problems inherent to riverside-riparian areas. Although this paper may be entitled as a Study of Plants, it also looks into the state of riverside-riparian areas and how these certain plants can address their problem thereon. There are, however, other practices and solutions that can be applied to the areas. Examples are the following:

- Allow natural riparian vegetation to grow unimpeded
- Where natural vegetation is gone, reintroduce species that are adaptable and found on riparian areas.
- Where access is needed for recreation and the like, use elevated walkways that are grilled to allow light to shine to the ground and for the plants to grow.
- Create a buffer zone between riparian habitats and development at least three times the width of riparian areas. These buffer zones will in turn be planted to several species of plants favorable for riparian restoration, recreation and wildlife habitat.

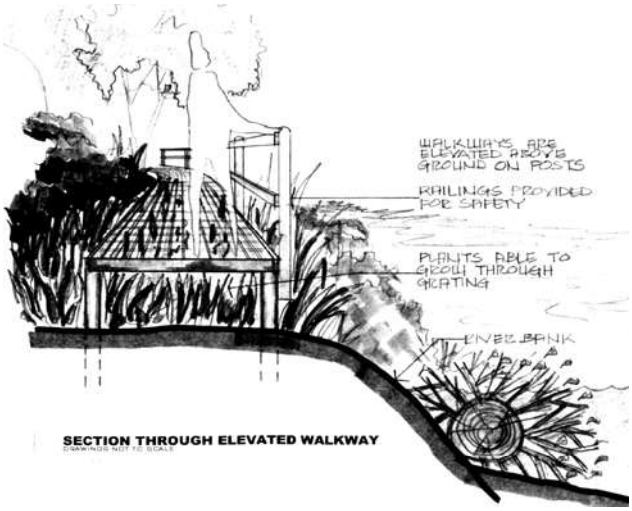

Figure 17 - Sample of Elevated Walkway

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