THE RIVER FLOW RIGMES AND TREE SPECIES:

The analysis of the orientation of the downed trees in relation to direction of the flows, and the relationship between the coppice circumference and distance from the active channel of Kuiseb River, Namibia.

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WADE PROJECT – DRFN, 2007

Introduction

River channels, especially non- perennial ones and the floodplains have tree species that grow along them. Higher soil fertility and water availability, usually associated with riparian areas, enable these trees to grow bigger than the surrounding ones. However, river flows, especially when are strong, knock down some of the trees found in the watercourse. Nevertheless, some riparian tree species of the western catchments of Namibia, for instance, are well adapted to the natural variability in flow regimes (Jacobson *et. al.*, 1995). When some tree species are knocked down just die, however; whereas there are those that rejuvenate through coppicing. Coppicing is therefore one of typical adaptability character of tree species in riparian forest of the western catchments of Namibia. Three trees species, namely, *Euclea pseudebenus, Faidherbia albida* and *Tamarix usneoides* in the Kuiseb River are known to coppice when knocked down by flows; and the direction in which a tree falls can be influenced by the flows (Seely, 2007, pers. comm.). Among others, it is however not known to which direction the tree face when knocked down. As a result, this study hypothesized that all downed trees would face down stream in the direction of the river flow if knocked down by high flows, and the size of the largest coppices would indicate trees that were knocked down earlier and vice-versa; tree with largest coppices would be further from the current main river course, and the opposite is true.

Objectives

The main objective of the study was to investigate if there is a relationship between the circumference of the coppice of *Euclea pseudebenus, Faidherbia albida* and *Tamarix usneoides* and the distance from the main river channel; and if downed tree face in a direction of the flows. The specific objectives were:

a) To determine the geo-positions of individuals of *Euclea pseudebenus, Faidherbia albida* and *Tamarix usneoides* that are knocked down and have coppiced;
b) To determine the orientation (in degrees) for each individual tree;
c) To measure the circumference of the largest coppice on each individual tree;
d) To determine the number of shoots/coppices on each individual tree;
e) To determine the distance of each individual tree from the main river channel, and
f) To map the main river channel and the floodplain.

Material and Methods

The study site covered the length of about 1.24 km of the Kuiseb River, upstream of Gobabeb Training and Research Centre. Coppicing individuals for *Euclea pseudebenus, Faidherbia albida* and *Tamarix usneoides* were targeted. Geo-position and the orientation of each downed individual tree were determined using a GARMIN GPS III PLUS. The circumference of the largest coppice on each individual tree was measured using a tape measure. The number of the shoots/coppices on each downed tree was also counted. The so-called floodplain and the main river channel were mapped. Then, data were entered in Geographic information system – ArcView 3.1 for analysis.

Data manipulation

Zones with 5 m width each were created around the main river channel. Trees within the main channel were coded with 0 m; within the 5 m from the main channel coded with 5 m, and so on until all the trees were coded with the distance of the zone in which they were. The orientation of trees and main river channel were classified using the method proposed by van Zuidam (1985). In addition, the floodplain was then divided into three polygons where by the direction of the main channel, as it meanders at each section, was used as a decisive criterion to divide the floodplain into polygons. The polygons were: polygon west, polygon north and polygon northwest.

Results

Within the study area, 45 individuals of *Euclea pseudebenus, Faidherbia albida* and *Tamarix usneoides* were found knocked down. But only 43 of these individuals have coppiced. The other 2 individuals that did not coppice are *Tamarix usneoides*. For those that coppiced, 69.8 % are *Faidherbia albida;* 27. 9% are *Tamarix usneoides* and 2.3 % *Euclea pseudebenus*. About 84% of the knocked down trees are on the northern side of the main river channel. The knocked down trees were mainly concentrated along the current main river channel, and not throughout the floodplain (Fig. 1)

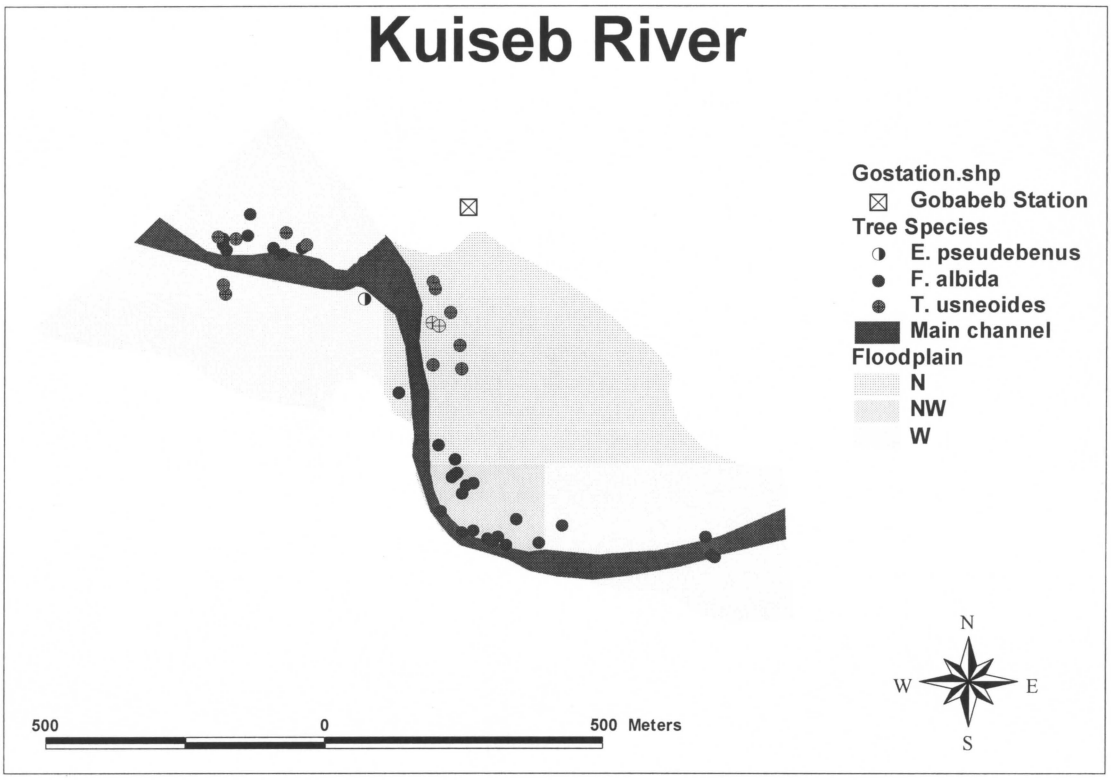

Fig. 1: The distribution of the coppicing individuals of *Euclea pseudebenus, Faidherbia albida* and *Tamarix usneoides* in the study site, Kuiseb River, Namibia

Tree orientation

As visually recognized, the current main river channel, as it meanders, orientates into three directions, namely: north, northwest and west (Fig. 2). When the orientation of each tree was measured and determined, four orientations were found, specifically: north, northwest, southwest and west (Fig. 2). It is found that 50 % of the trees facing to the west were within the polygon which was classified as "west"; 71.4 % of the trees orientated to northwest were in the polygon "northwest", and only 27.3% of the trees orientated to north were in the polygon "north" (Fig. 3) .

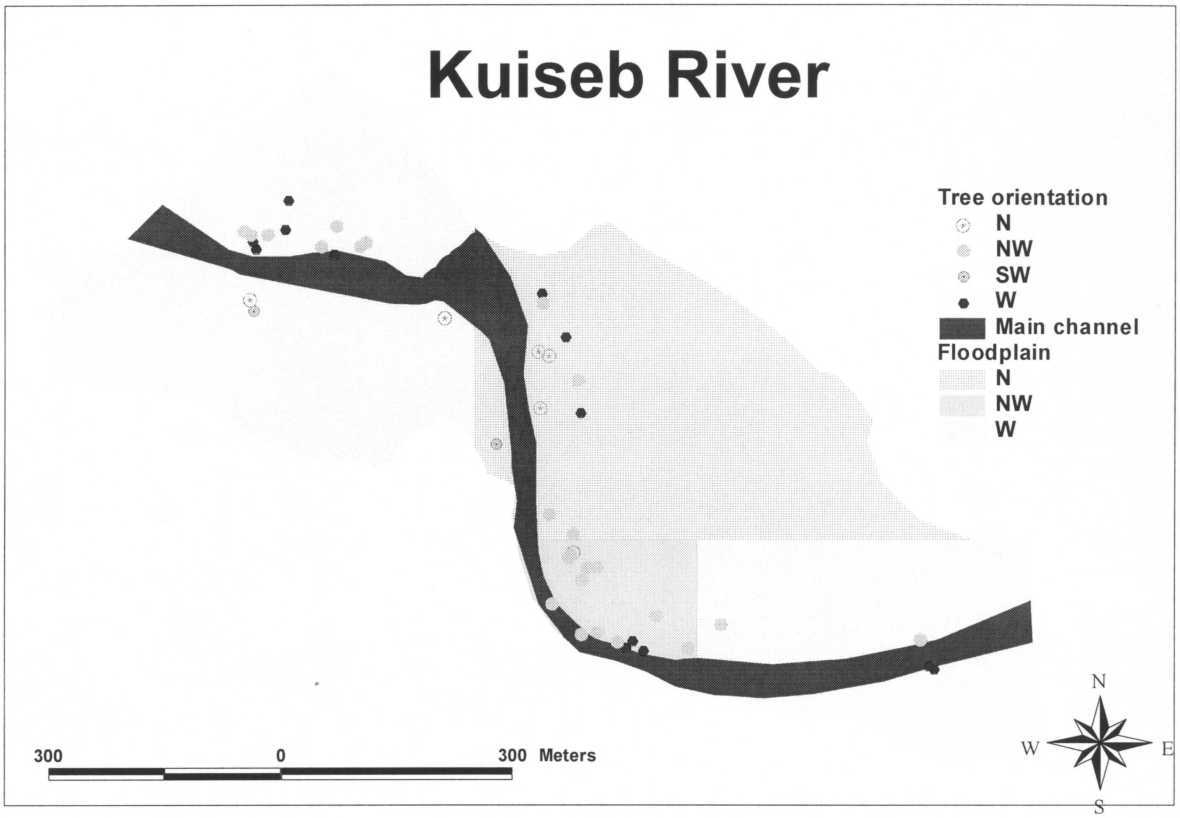

Fig. 2: The orientation of the trees in relation to the flow direction of the main river channel of Kuiseb River, Namibia

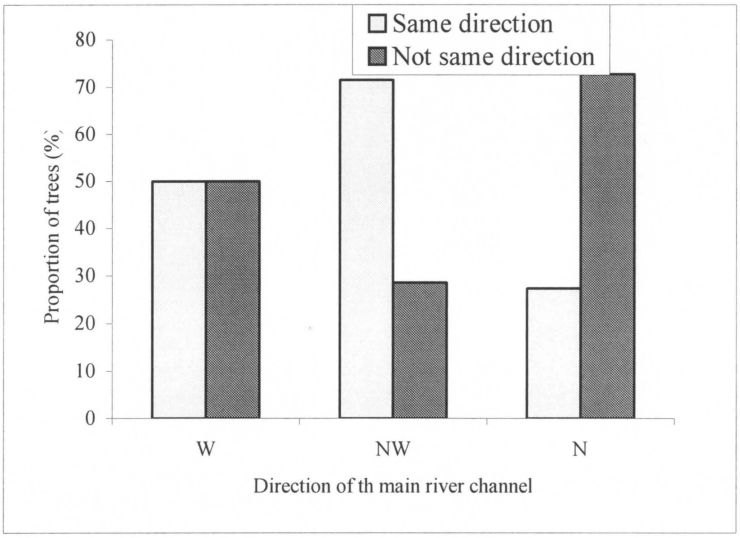

Fig. 3: The proportion of trees that face and those that do not face in the same direction of the main channel in each polygon

Distance from the main river channel and coppice circumference

The circumference of thickest coppice, among the recorded largest coppices, of *Faidherbia albida* was 132 cm, and the circumference of thinnest coppice, among the largest coppices, of *Faidherbia albida* was 11 cm. For *Tamarix usneoides,* the circumference of the thickest coppice, among the largest coppices, was 85 cm whereas the thinnest coppice among the largest coppice was 14 cm.

The closest tree to the main river channel was within the channel whereas the furthest tree was about 70 m away. At the narrowest section of the study area, the entire river was about 236 m wide. The relationship between the distance from the main river channel and the thickness of the coppices of *Faidherbia albida* appears to be weak ($r^2 = 0.0748$) (Fig. 4), and the same is true with *Tamarix usneoides* ($r^2 = 0.0078$) (Fig. 5). As such, the relationship between the distance from the main river channel and the circumference of the largest coppice on each coppicing tree can not be used to estimate recentness of when a particular tree was knocked down.

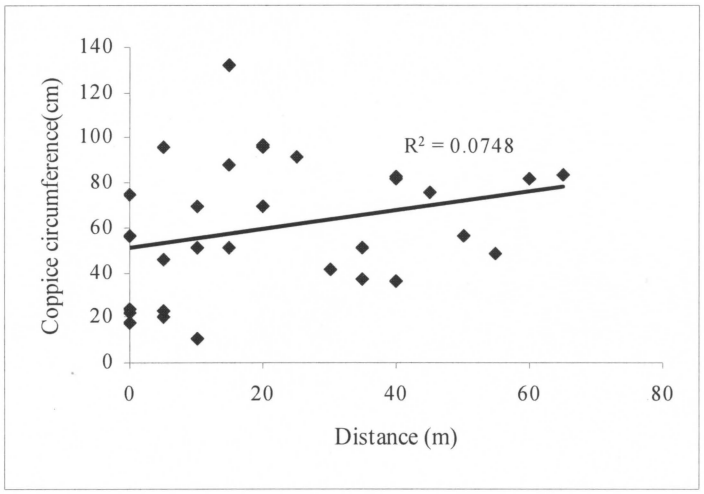

Fig.4: The relationship between coppice stem circumference of *F. albida* and the distance from the main channel of Kuiseb River, Namibia.

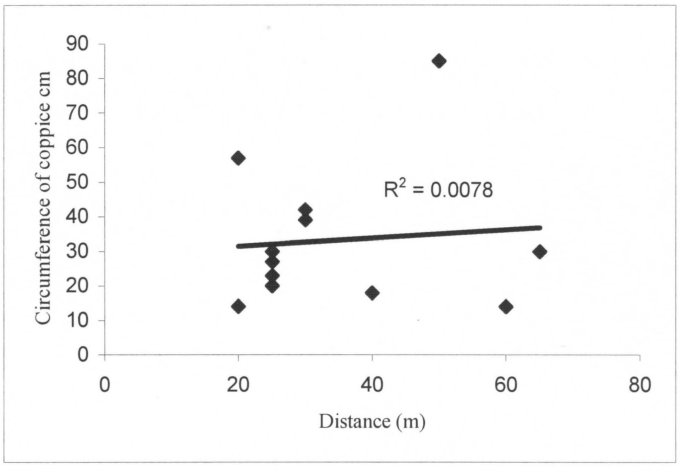

Fig.5: The relationship between coppice stem circumference of *T. usneoides* and the distance from the main channel of Kuiseb River, Namibia.

Coppice circumference and number of shoots

The highest number of shoots/coppice recorded on an individual of *Faidherbia albida* was 24 whereas the lowest number shoots recorded on the individual of the same species was 1. For *Tamarix usneoides,* the highest number of shoot recorded was 30 and the lowest number of shoots was 1. The relationship between the circumference of the largest coppice and the number of shoots revealed weak association for both *Faidherbia albida* ($r^2 = 0.0019$) (Fig. 6) and *Tamarix usneoides* ($r^2 = 0.012$) (Fig. 7).

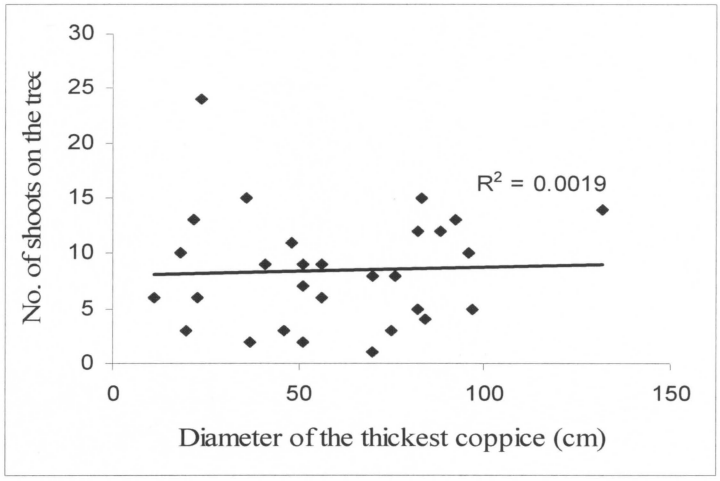

Fig.6: The relationship between circumference of the thickest coppice of each *T. usneoides* individual and the number of shoots on such individual Kuiseb River, Namibia.

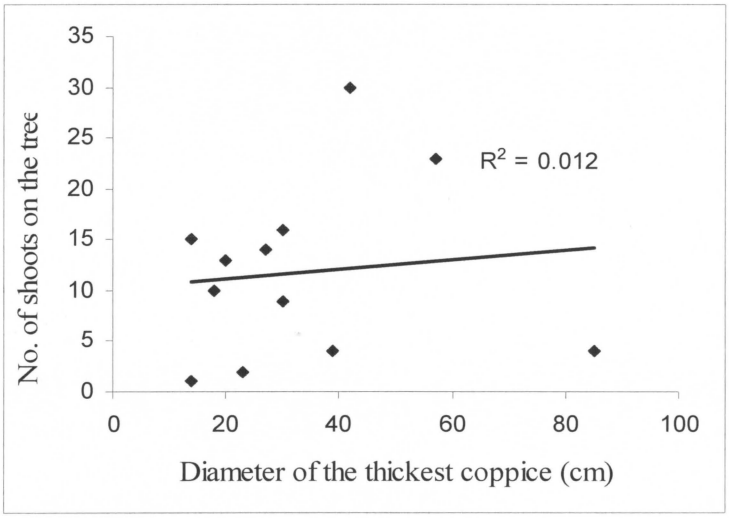

Fig.5: The relationship between coppice stem circumference of *T. usneoides* and the distance from the main channel of Kuiseb River, Namibia.

Discussion

As the results revealed, the circumference of coppice for *F. albida* and *Tamarax usneoides* did not necessarily increase with the distance from the main channel of Kuiseb River, Namibia. Generally, when all other conditions are the same, trees of the same species that coppiced first would have thicker coppices than recently coppiced ones. But measuring the coppice against the distance from the main channel seemed to be less, if not at all, likely to reveal the trees that were knocked down earlier. This is because, in most cases, the main channel keeps on shifting within the floodplain, and such shift does not happen systematically. Also, as the main channel meanders, due to dual processes of deposition and erosion, it may not shift at some section and does at other sections. Implicitly, the main channel may therefore stay at some positions much longer than at other point where it has shifted. At the section where it has not shifted, trees that are knocked down would remain closer to the main channel compared to their counterparts where the channel has shifted. Furthermore, shifting of the main channel does not keep on happening toward one side of the floodplain. Jacobson *et al* (1995) also indicated that episodic massive floods create new channels within the floodplain. As such, the main channel may shift back where it has shifted from some years back; and trees on such section would be in the main channel although they were probably knocked down long time back. Such dynamism of the main channel makes it less possible to use distance from the main channel to depict trees that were knocked earlier or recently.

Apart from the dynamism of the main channel, assuming that growth of the coppice stem thickness is continuous appears to be too generalist in this case. The thickness of the stem of the coppice would ultimately be depended on the size of the supporting mother trunk, and the growth of the mother trunk appears to be influenced by the nature of the damage when such tree was knocked down. For instance, some coppicing individuals have few live roots after the damage. Logically, tree with several roots are advantaged when it comes to water and nutrient uptake compared to ones with few roots. Consequently, trees that were heavily damaged and have few roots would not have their coppices grow favorably as it would be with other less damaged individuals. Therefore, use of coppice circumference and distance from the main river channel appeared not to be an appropriate approach to indicate when (in term of recentness) the tree was knocked down.

Moreover, assuming that trees knocked down earlier would have more shoots and thicker coppice than the recent ones is not supported by the results. The number of shoots on the mother trunk is likely to be depended on the damage made on the individual tree. Jacobson *et al* (1995) also documented how these trees respond vigorously when damaged. It therefore seemed that the number of shoots or coppices on an individual tree would ultimately depend on the magnitude of the potential created after the damage.

Conclusion

The relationship between the coppice circumference and distance from the main river channel, both for *F. albida* and *T. usneoides*, was weak; so, the coppice circumference and distance could not reveal how recently a tree was knocked down. Also, coppicing trees with larger coppice (shoots) did not necessarily have high number of shoots (coppice) on them.

References

Jacobson, J. P., Jacobson, M. K. and Seely, K. M. (1995). Ephemeral Rivers and their Catchments: Sustaining people and Development in Western Namibia. Desert Research Foundation of Namibia, Windhoek, 160pp.

van Zuidam, A. R. (1985). Aerial photo-interpretation in terrain analysis and geomorphologic mapping. Smits Publishers, Netherlands.