Hydrology and Earth System Sciences Discussions

Interactive comment on "Flexural behaviour of selected plants under static load" *by* F. J. Sutili et al.

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Finale response to referee 1

General comments The paper is surely interesting. - The desiderable characteristics of the plants for soil-bioengineering purposes should be better outlined referring to elasticity (bank protection and decreasing roughness and flow resistance after bending, not only bank stabilization and/or lever effect, cfr. P1472 L16), plasticity (permanent deformation, survival, etc.), and breaking (survival after "natural" coppicing or pruning).

RESPONSE: The general requirements of plants for soil bioengineering applications are revised in the introduction to demonstrate the impacts of specific plant properties

from an engineering point of view. We agree with the referee 1, who addresses the different effects of plants according to elasticity, plasticity and breaking.

- TITLE: suggestion for this Journal: Flexural behaviour of selected riparian plants under static load

RESPONSE: We change the title according to the suggestion of the referee 1.

- P1469 L16-26: suggestion: please, move to Introduction section

RESPONSE: We move it to introduction in the revised manuscript and rewrite the text to improve the understanding

- Statistical tests are missing.

RESPONSE: The data sets are based on complex local environmental factors of growing conditions. The research work focus on the simulation of the physical bending process of the selected specimens to gain a better understanding of soil bioengineering systems under hydraulic stress. We are absolutely aware that we have used a simplified approach in comparison to the real situation not only considering the sampling size (to draw conclusions regarding the basic set) and finding statistical significance, but also when plants are dynamically stressed during a high flood event. However the authors are convinced that the sampling size and the used method are helpful to improve the insight in the field of soil bioengineering.

- Authors incurred in a systematic mistake in the three points loading test, due to the "flexibility" of the green stems: the geometrical configuration of the test (as stated by DIN 52186 [Tests on wood. Bending test]) is no more valid when the stem is going to be bent so much that ray of the curved stem in the centre is lower or equal to the ray of the semi-cylindrical head of loading. In this situation, when the loads are high enough, the geometry of the test is completely lost, as well shown in the snapshot of the text: 1) bending moment is unknown because, for the shifting of the stem on the supports, the "lever arm" is changing (bending moment $Mf = l/2 \times F/2$, actual l is shortening with load

increasing), 2) direction of the forces are no more vertical, 3) the contact points (on the shifted stems), are four and no more three. So in this situation it is not possible to know the true stress on the stem. This systematic error is increasing with the slope of the stem and with the growing of the load, but it can change, stem by stem, due to the combination of load, modulus of elasticity, slope, etc. The recommendation is: Authors have to rewrite the text, pointing out that some important assumptions due to the lost of the three point loading geometry have been done and specifying all the effects on the other results. Differently, if the Authors think that the effect of the loosing geometry is negligible, they have to declare it explicitly, explaining and demonstrating why it is not significant.

RESPONSE: Green stems are "flexible". The figure 1 is misunderstanding, because it does not show the real bending conditions during the experiments. In fact the figure is used as schematic to show the different parameters. The figure will be replaced by another one which represents the "real" conditions under extreme load. We also mention in the revised paper that we take care of a constant geometry (angle < 65), please have a look at the revised figure 1.

- The proof-reading by a native speaker and the translation of some technical words are recommended.

RESPONSE: Done

- The check of quotations and references in the biography is recommended. A list of symbols and the check of all the formula and units of measurement are suggested (also in tables, figures and captions).

RESPONSE: A proof reading and a check of the quotations and references have been done in the revised manuscript.

Answers to the specific comments of referee 1: - P1460 L13 and P1472 L5-8 new "value" "new" sounds a little bit ambitious; "parameter" not "value"

RESPONSE: Done - P1460 L15:engineering practival experience engineering practical experience

RESPONSE: Done

- P1460 LL21 and 23, P1472 L11 and L20:"river banks", "riverbanks" and "fluvial slopes" "river banks", not "riverbanks" and not "fluvial slopes" (if it is synonymous and the meaning is cross sectional and not longitudinal)

RESPONSE: Done

- P 1461 L 14 and References: Righetti

RESPONSE: Done - P 1461 L 13-15: chronological or alphabetical order

RESPONSE: Done - P1462 L14 and Table 1: 50 samples in 6 diameter classes: only 8 for each class? Response: Please have a look above – explaining of the sampling size of 50 specimens.

- P1462 L19 and 20: The setup of the bending tests is based on the DIN standard (DIN 52186) for 3 point loading tests.It is no true at high load (see P1467 L11 below).

RESPONSE: Please see above the comment about the systematic mistake

- P 1464 L10-17: Felast "l" and "I wrong formula, check for "Felast", "felast", "l" and "I" and dimensions

RESPONSE: There was a problem with the typeface (no difference from l and I) generating a pdf file; we will take care of a differentiation and correct dimensions. The formulas have been revised.

- P1465 L4: ïĄě = f 12 d / l^2 Probably 6, not 12.

RESPONSE: It was proofed

- P1466 L15:Editing Return after [g]

RESPONSE: Done

- P1466 L15:"and the basic apparent speciïňĄc weight of the wood" probably "Basic density"

RESPONSE: Done

- P1466 LL17, 20 ïĄš = mo /V and; V volume of wood [cm3] the moisture content of the piece of wood, which weight and volume have been measured, must be zero for Mass and green (more than 30%) for Volume

RESPONSE: ïĄš = m0 /V ; It is correct, mass at dry condition and green for volume

- P1467 L7-11; P1467 L7: ... angle of flexibility .. there is a basic problem in this kind of test, due to the high plasticity of green stem: at high loads the geometry of the test is no more correct and the true stress (and also breaking stress) is not known. We can say that it is a methodological mistake.The final angles are influenced by geometry of the test. Better "parameter" than "value"

RESPONSE: Please have a look at the comment above

- P1467 L22-23: Repetition: basic – basic

RESPONSE: Done

- P1468 L1: The first statement (relation between diameter and basic weight) has no graph

RESPONSE: Another graph was generated (density against moisture) to show range of density depending on the moisture content (fig. 2). Revised text: Phyllanthus sellowianus showed in general and independently of the moisture content higher values of the basic apparent density than all other species (Figure 2). The slower growth and the higher average of age of the specimens of Phyllanthus sellowianus are possible causes.

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- P1468 L18 It seems strange (Fig. 3) a linear relation with intercept $\neq$ 0 instead of a power curve with intercept = 0.

RESPONSE: We change it from linear relation to a power curve with intercept = 0; see fig. 3.

- P1468 L21: ...the most fragile. probably "...the most weak" because in the materials behaviour defined "fragile" is another thing.

RESPONSE: We rewrite the text to improve structure and understanding: Figure 3 indicates the force (F) for different diameters which is required to reach the proportional limit (solid line) and the point of rupture (dashed line).Phyllanthus sellowianus is the species most resistant to bending and Salix humboldtiana is the most flexible one. This means that for Phyllanthus sellowianus a higher amount of load is necessary to reach the point of elastic limit and the point of rupture respectively.

- P1468 L28; P1469 L1: The calculated moduli of elasticity are comparatively lower than .... of five European species no consideration about the relationship between E and density (or basic density). Obviously density of 5 European species could be so much higher than species studied.... or not!

RESPONSE: We take the suggestion of the referee and consider beside E also the basic density; but the density from the European species are calculated by density r=M0/V0 which is different to the r = M0/V with V = volume of the green stem

- P1469 L6: cfr. with relationship E[Mpa]=696/d [mm] for roots (Fan&Su, 2008 and Operstein,& Frydman, 2000 in Schwarz et al., ESPL 2009)

RESPONSE: The referee mentions a publication about research work of quantifying root reinforcement. In this context root mechanical properties such as Modulus of Elasticity are discussed. We want to address that even it is the same parameter (MOE) above surface sprouts and root are not comparable from a anatomical and physiological point of view. This is explanation why we not refer our research work to this one.

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- P1469 L6: The modulus of elasticity declines with the increase in diameter.No consideration about the possibility that in this research cork + bast contributed to elasticity (as cited in 1468 line 14). This contribution can be less and less significant as the diameter decreases

RESPONSE: We considered the impact of the bark to elasticity; the used citation of 1468 L14 was moved to the chapter 3.2 (Modulus of elasticity) to discuss our results with other research works.

- P1469 L16-26: To be moved to Introduction section

RESPONSE: Done

- P1470: Angle of flexibilityf and angle fleibility are explicitly related. Due to the geometry of the test these values can not be considered correct because there is a methodical error, varying with diameters.So can be use only as a qualitative indication.

RESPONSE: Please have a look at the comment above

- P1470 L8-10: relationship

RESPONSE: Done

- P1470 L1-13: To be clarified RESPONSE: Done

- P1470 L15:textit?

RESPONSE: The relationships shown in Figure 8 is specific to the different local environmental growing conditions and can be taken as reference values for the growth rate of the species.

- P1471 L13-15:not above?

RESPONSE: ok

- P1472 L2: Fig. 9; figure 9 is lost

RESPONSE: numbering and design of figures were revised

- P1472 L11 and L20: river banks?

RESPONSE: Done

- P1472 L16:most important flow resistance, erosion protection, river bank stabilization

RESPONSE: Revised text: It was proven that Phyllanthus sellowianus and Sebastiania schottiana are very appropriate for the protection of river banks according to the criteria of stem flexibility, inflection angle, resistance to rupture (stem breakage), growth rate and plant size. Riparian forest stands of Salix humboldtiana and Salix ïĆť rubens need more frequent maintenance in order to preserve its "flexibility function".

- P1472 L18 and L24: branch pruning and trunk or stem coppicing

RESPONSE: Done

- P1472 L27:practice?

RESPONSE: Revised: Under natural environment conditions plants are stressed in a different way compared to the laboratory.

- P1473 L1: Declare that a dstributed load test should be preferable

RESPONSE: We take this suggestion from the referee

- Add e.g. standard error and not only R2.

RESPONSE: Table 1 was revised; Table 1: Average values of the modulus of elasticity at green state [N/mm^2] for the different diameter classes of each species. Standard deviation and coefficient of variation [%] are shown in brackets. (see fig.4)

- Fig 7: Diameter/age correlation is not linear.

RESPONSE: We agree that in general the diameter and age don't show a linear relationship. The linear relationships in Fig. 7 represent the correlation according to the
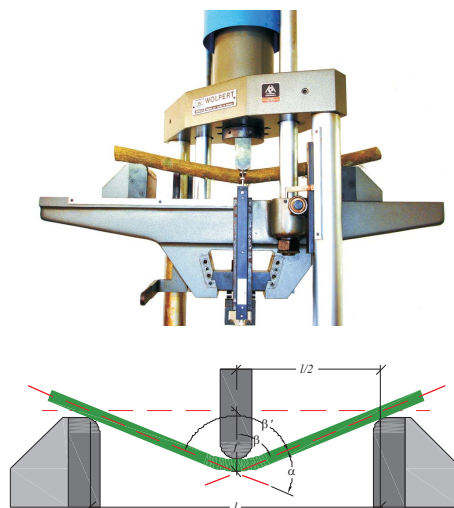
specific temporal period of consideration (age from 1-12) of the selected specimens. We have revised the text.

- Fig. 9: Missing RESPONSE: numbering and design of figures were revised

Fig. 1. Fig. 1: Photography and bending diagram, indicating the variables used in calculating the angle of inflection (α).
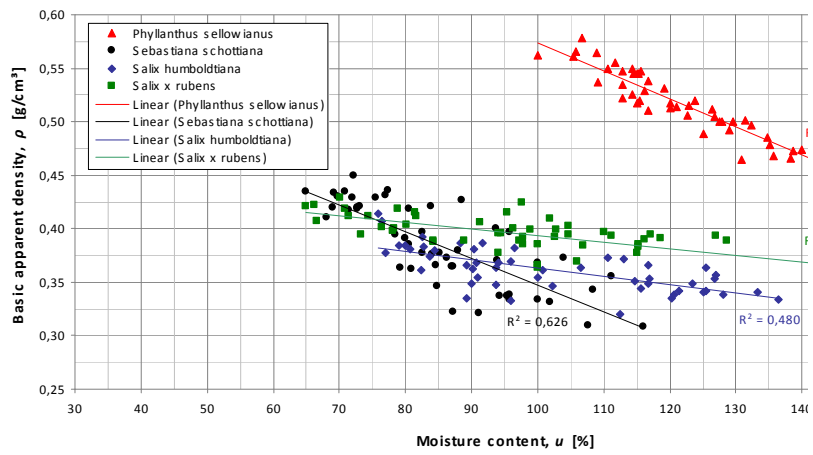
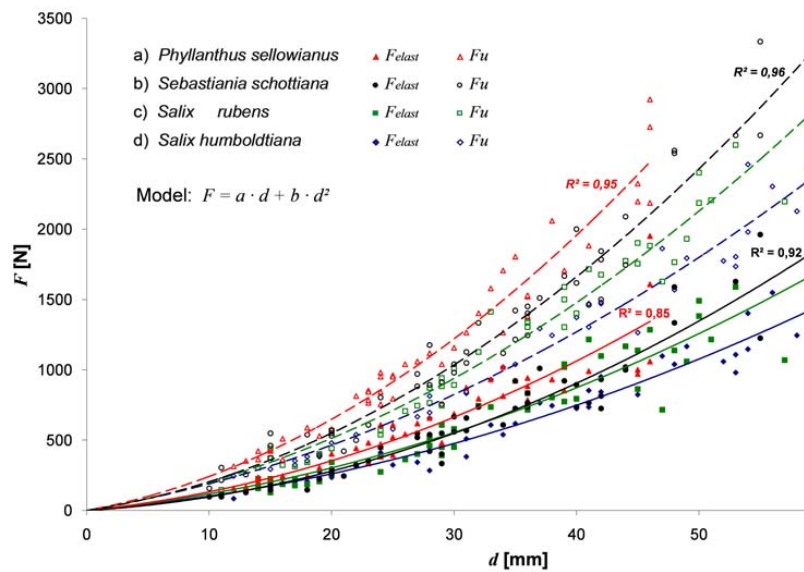**Fig. 2:** Relationship between diameter, basic apparent density and moisture cont

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Fig. 3: Relationship between diameter (d) and load (F). Solid line: F_{elast} at the pr
dashed line: F_u at the point of rupture.

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Table 1: Average values of the modulus of elasticity at green state [N/mm²] f
diameter classes of each species. Standard deviation and coefficient of variation
in brackets.

Species	Modulus of elasticity [N/mm²] per diameter cl:				
	10-20mm	20-30mm	30-40mm	40-50mm	50-60m
Phyllanthus sellowianus	4,513 *(889;20)*	3,793 *(1173;31)*	3,329 *(835;25)*	3,028 *(825;27)*	------
Sebastiania schottiana	4,615 *(1188;26)*	3,930 *(1126;29)*	4,104 *(1273;31)*	3,485 *(432;12)*	3,114 *(575;18,*
Salix × rubens	4,940 *(1726;35)*	4,562 *(1312;29)*	4,296 *(1054;25)*	3,555 *(1208;34)*	3,625 *(766;21,*
Salix humboldtiana	4,084 *(1590;40)*	3,347 *(630;19)*	3,254 *(388;12)*	2,822 *(925;33)*	2,419 *(285;12,*

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