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Hydrology and Earth System Sciences Discussions

Interactive comment on "Suitability of soil bioengineering techniques in Central America: a case study in Nicaragua" *by* A. Petrone and F. Preti

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RESPONSE TO ANONYMOUS REFEREE #1 AND #2

Response to anonymous Referee #1

Specific comments: 1. Abstract does not reflects the summary and results of the work.

The abstract in the revised manuscript has changed to take into account the referee comment.

2. Lines 13-15, page 383; it is mentioned that the cuttings were collected from 9 plants, 7 plants, 4 plants etc., Is there any importance in these figures? Why there is variation in sampling? Is there any difference in cuttings obtained from different plants? Are they affects the survival rate?

We deem the observation to be correct. Actually, the criterion we adopted implied the sampling of a different number of mother plants. This was explained in the answer to the specific comment of Anonymous Referee #2 P 381 line 13-15.

3. Lines 3-4, page 384; after which, between 28, 29 and 30 January. Do you mean it is the time the plants were transferred to site?

Yes.

4. Line 9, page 384; give a small description about the arrangements done to make it homogeneous.

To clarify this point we added the following description in the paper:

Cuttings, for a total of 200, have been placed on three ranks of the live crib wall, for a total of 30 m with a planting out density of a specimen every 0,15 m. Homogeneity of planting out was achieved by alternating a species with another by repeating the sequence Gliricidia sepium, Cordia dentata, Jatropha curcas, Bursera simaruba.

,5. Line 12, page 384; instead of saying certain parameters, mention the parameters which can be used for measuring plant growth and also explain why you selected only these three parameters.

To clarify this point we added the following part in the paper:

The three parameters used are: survival rate, length of apical shoot, diameter of apical shoot. As far as the first one is concerned, not many explanations are needed: in fact, it is important to assess this parameter in order to privilege species with higher values. According to Schluter (1971), for example, only plants with survival rates of at least 70% should be considered for use in bioengineering practice. As far as the second parameter is concerned, the relationship between shoot and root development allows estimation of overall rooting performance and consequently, the anchoring and soil binding functions of the plants (Lammeraner et al., 2005). Not only is the measure of the third parameter needed in order to assess the degree of vegetative development

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of the plant, but it is needed above all to understand how long will the shoot remain flexible: in fact, in case of intervention on the bank of a river it is of vital importance that shoots keep their elasticity and bend themselves to the running water without making resistance. It is generally considered that a 4 cm. diameter constitute the upper limit for not losing flexibility. Substantially, measurement of the development of the shoot diameter provides a fundamental information on how frequently to perform felling operations.

6. The figure captions do not match with the explanations given in the text. Example: figure 5, 10.

The new Figure 5 illustrates the presence of radicles and small leaves in the cuttings of Gliricidia sepium (as reported in the text). Figure 10 provides an overview of the operation, where it can be noticed the sedimentation in the lower part (we will add this part to the relative caption).

7. Line 14, page 381; have you made any comparison of the results obtained from two sites?

In fact, as illustrated in the text, we are not dealing with two different experiments performed in two different sites, but with one only experiment, which in the first stage (cutting nursery) was performed in an area and then was continued through the planting out of cuttings in the riverbank protection.

8. 3.3 and 3.4, page 386; does not explain anything regarding the observations and the results.

In fact, in regard to monitoring activities reported on paragraphs 3.3 and 3.4, it was chosen to supplement the presentation of the related results inside the following paragraph, which is named Discussion. We have restructured those paragraphs by following the referee's suggestions.

9. Line 10, page 387; among the various possible causes..?, what are the other possi-

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ble causes? Why do you think that the cause of failure is transportation damage? Is it because of the distance to the site? Is their any relation to the soil condition or climatic conditions?

In regard to climatic conditions, their influence could not be negative, because cuttings were drawn from an area whose conditions were equivalent. According to bibliographical sources Bursera simaruba is a specie which can be found in a wide variety of climates and soil conditions. In Nicaragua, it is located in the subtropical dry-area, subtropical damp-wood area (warm and temperate), subtropical very-damp-wood and subtropical low mountain wood, at heights of from 0 to 1100 meters. In regard to soil conditions, it can adapt to a wide variety of soils, including chalky and rocky ones, it grows quite rapidly in deep soils, of a texture which ranges from sandy-loam to clay-loam. In spite of this we have to stress that this specie is less widespread than the others in the project area, as above mentioned. In our case study it cannot be excluded the effect of the competition with the other three species. Moreover, as reported in the text, the hypothesis formulated in relation to damages occurring during transportation is just due to the fact that this kind of cutting was drawn from a site that was more distant than the others. In fact damage during transportation is acknowledged by those who deal with soil bioengineering as one of the most frequent causes of low survival rates. From that we arrived to formulate the mentioned hypothesis, which remains just a hypothesis (and it is not the only one): it would be appropriate to perform specific studies in order to verify it. We have clarified this point in the revised manuscript.

10. 4.1, page 387; cost comparison is not clear.

See response to comment P387 line of Referee #2.

11. Conclusion shall include the findings of the study.

The finding of this study is to have identified three local species suitable for riverbank protection with Soil Bioengineering techniques and to have demonstrated their economic efficiency.

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General comments: 1. figure captions should match with that referred in text

In effect, there is an error in the text concerning Fig. 1 (Line 17, p. 383) which must be substituted with Fig. 3. As for the rest, we will insert references to each of the reported figures and tables.

2. Superimposing figures 2 & 9, may give a clear idea of how the growth of plants varies with precipitation.

In fact, that was not possible because the planting out of the cuttings was done during the dry season, and the rooting of the cuttings was favored by the initial irrigation until the advent of the rainy season.

3. Structure of the paper needs improvement with respect to the observations, comparison, analyses and then discussion.

We improved the paper considering all the comments as suggested by Referee#1.

Response to anonymous Referee #2

Specific comments:

P 380 line 15: The technique of soil bioengineering has been very old (age of several thousand of years) and in Central Europe it was rediscovered again in the last century. On this account also the pioneer phase has started much earlier.

We were referring to the widespreading stage which began with the rediscovery (and revisitation) of the soil bioengineering techniques. In Italy too the pioneer stage starts more than one century ago with the Sistemazioni Idraulico-Forestali (Watershed management). Such rediscovery, followed by an always growing proliferation of those techniques, occurred around the end of the '80s and continued through the '90s.

P 380 line 16-20: Soil bioengineering is based on two fundamental issues independently from a world wide application. The basic for each application is the suitability of soil bioengineering plants and second special techniques are used depending on what

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is required for civil engineering structures. Therefore it is possible to transfer soil bio-engineering techniques to developing countries but fort the potential local bioengineering plants basic research is essential. Most of the mentioned projects focusprimarily on plants to understand the technical and biological properties. The two steps (plants and techniques) should be clearly separated.

The useful comment has been inserted in the text in order to clarify this aspect.

P 380 line 23: Why there is an interrelationship between best type and temperature and pluviometric conditions. A type (soil bioengineering technique) is much more relating to specific geotechnical and hydraulic aspects of the construction site. No focus is given to an economical issue, even though it is mentioned as one of the main results in the abstracts.

At lines 21-25 we illustrate the targets of our previously mentioned under-way researches. Certainly, the choice of a technique instead of another depends mainly on the geotechnical characteristics and the hydraulic aspects of the construction site, as referred by the Anonymous Referee #2. Despite that, the fundamental difference between the Mediterranean and the tropical context, for example, does not relate to these aspects, but rather to those that are related to the presence of very distant temperature and rainfall patterns. For example, Lammeraner et al. conclude by stating that: our results suggest that drainage fascines were not suitable for use in winter plantation and should be replaced by other techniques used for stabilisation of rill erosion. (Lammeranner et al., 2005). The idea is to analyze what techniques bring the best results at the same geotechnical and hydraulic conditions of the construction site and taking into account the local climatic regime. In fact, economic aspects are not given a wide prominence in the mentioned works. Instead, the present work tries to take these factors into account.

P 381 line 1: First results are already mentioned in the introduction.

The results that are mentioned in the introduction concern the mentioned studies, not

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the text the referee is commenting upon. Results of the present study will be shown in the following paragraphs.

P 381: Background and the criteria of the selected plants as well as the species of plants are described reasonable and in detail.

P 381 line 13-15: From the point of vegetative reproduction the number of different plants is a decisive factor due to their genetic provenance. Why were unequal numbers of different plants for each investigated plants configured. This is a relevant issue to a homogeneous sampling size for the different plants.

We agree with the referee #2 and we want to thank him for the suggestion that made possible to improve the paper as follows: The unequal number of the plants is certainly a decisive factor for their survival rate. Having set a significant minimum number of plants per each species, we had to go a longer distance in order to carry out the sampling of the least common species (Bursera simaruba). Within a range which was equal to such a distance, we reckoned the number of plants per species we had to sample should have been proportional to their frequency. We deemed such a criterion could have been valid for assessing the use of the living material which was available in loco for use in soil Bioengineering.

P 383 line 20-24: The plantation of the cuttings is described. The vertical plantation of the cuttings is not the optimised method, which was mentioned by the authors. The average length of the cuttings was around 150 cm. But the holes for plantations have just been a depth of 30 cm. What is quite unusual for soil bioengineering cutting plantation is the relation of the part which is covered by soil to the residual part of the cutting and does not fit with the general technical of cutting plantation.

The sampling of the cuttings was performed in order to realize soil bioengineering works. Therefore, their length could not amount to less than the thickness of the works we intended to manufacture (150 cm). Moreover, the excavation which was done for the planting out in the experimental nursery and the following excavation were carried

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out by students and without help of any mechanical means.

P383 line 25-30: All the plantations were irrigated in the same to simulate the monthly mean precipitations between 1974 and 2000. It could be interesting for future bioengineering research work to know something about the resistance of dryness of different plants especially if this is a limited factor for the local suitability of plants.

In fact, we are experimenting it during these months and still in León (Nicaragua) just in order to verify this aspect. We worked on a slope using various techniques and six vegetable species during the final period of the rainy season. The results of this study are being processed.

P384 line 2: It the plants have been extracted (and not excavated), it is not clear how the rooting performance can be quantified. A detailed scientifically methodology is missing. The meaning of rooting percentage (is it the same as survival rate?) and vigour (methods?) is not clear. Essential plant parameters such as above and below biomass, numbers, diameters and length of new shoots are not considered.

In fact it is a mistake: plants were excavated, not extracted. The meaning of rooting percentage is the same of survival rate in this context, while as far as vigor is concerned, during this stage we just performed a qualitative analysis based on a visual inspection. The essential growth parameters were measured afterwards (diameter and length of the terminal shoot) once having performed the planting out of the cuttings during the operation. We decided to measure those parameters only during this stage because what we were interested in which was the in-progress behavior, not in nursery.

P384 line 5: The slope grating is mentioned first. Is it an objective to compare a vegetated crib wall with a slope grating?

No, in this study we did not make such a comparison.

P384 line 11-15: A matrix table could be helpful to show clearly an overview what parameters at what time are the base of the data sampling.

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Tables 1, 2, and 3 shows the measured parameters.

P384 line 16: It is not clear what the meaning of a qualitative monitoring is?

In this context the expression qualitative monitoring refers to a kind of monitoring which does not take the measurement of parameters into account, but rather a general assessment of the general trend of the operation through visual inspections and photographic documentation. On the other hand, as reported in the text, Current survival rate measures are meaningless, due to the heavy sedimentation process which has occurred at the base of the live cribwall.

P384: Also the method of analysing (e.g. statistical tests) of all the data sets should be described in detail as a part of methodology.

We have moved the requested description from the paragraph Discussion to the paragraph Metodology.

P384-386: The results for the monitoring steps are presented in a different way according to scale and accuracy. The results of the first steps are described in detail whereas just the date of the last one is mentioned.

We agree with the Referee#2 comment and we have changed the results description consequently.

P387 line 10: What supposed by various possible causes of failure and transporting damage? Is it reasonable that this species of plant is not successful for vegetative reproduction.

See response to comment #9 of Referee #1.

P387 line: The considerations to the work cost are just part of the chapter of discussion. If it is an important part of this study it should also be part of the chapter methodology and results.

We agree with the Referee #2 and we want to thank him for the suggestion that made

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possible to improve the paper according to our aims and to those of the Journal (HESS wish to publish original findings on the interactions between hydrological processes and other physical, chemical, biological and societal processes within the earth system, and the utilization of this holistic understanding towards sustainable management of water resources, water quality and water-related natural hazards).

P394-403: All figures should be referred in the text.

In fact, the text has an error which pertains to Fig. 1 (line 17, p. 383) and which must be substituted with Fig. 3. As for the rest, referrals to each of the mentioned figures will be inserted.

P401: What kind of technique(Fig. 8)?

As reported on page 384, line 4, the construction of the riverbank protection constituted by a live vegetated crib wall and a slope grating.

P403: What kind of technique (Fig 10)?

As reported on page 384, line 4, the construction of the riverbank protection constituted by a live vegetated crib wall and a slope grating.

General comments: The paper needs to revised scientifically focused on the investigations to plant performances in the scope of soil bioengineering with a clear structure of problem definition, methodology, data sampling, analysis and results and finally integrated in the discussion.

We improved the paper considering all the comments as suggested by Referee#2.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 379, 2008.

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