**Hans H. Ruthenberg-Graduierten-Förderpreis 2008/**

**Hans H. Ruthenberg Award for Graduates 2008**

Juan Carios Laso Bayas "Assessment of physical mitigation provided by tree crops in the 2004 Tsunami event in West Aceh-lndonesia"

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## Summary

### Introduction: The tsunami and food security

The extent and intensity of the impact of the Indian Ocean tsunami in December 2004 were unprecedented in recorded history. In general, coastal areas in the world are home for over one sixth of total human population and especially in Asia, these areas are at least twice or three times more densely populated than the average. The province of Aceh, closest to the tsunami epicenter, is not an exception: Over 150,000 people died only in this province plus at least half a million lost their homes. Their well-established agricultural and tree crop system that were main source of income and subsistence were also destroyed: large parts of coconut plantations were damaged and rubber agroforests were severely affected, in particular at sites close to the coast line (Szczucinski et al. 2006). Prior to tsunami, as big as 40-60%'proportion of income were generated from tree crops such as coconut, rubber, coffee, cacao and oil palm (West Aceh District Government, 2002) and therefore people's livelihoods were greatly dependent on them.

### Problem definition

According to previous studies, coastal vegetation significantly mitigated tsunami damage, especially reducing casualties and structural damage (Danielsen et al. 2005, Tanaka et al. 2007). Mapping assessment (Borrero et al. 2006, EC JRC, 2005) indicated that along the coastline of Sumatra (Indonesia) major changes in land cover occurred, indicating a reducing effect on tsunami impact due to the presence of coastal vegetation. Many of these studies promoted a planting "boom" of green barriers or strips of trees along the coast line, which is believed to have a mitigation effect to tsunami. This boom has been criticized by several authors (Kerr and Baird 2007, Young 2006) who mention that no real proof for this mitigation effect exists and green barriers therefore may be giving a false sense of security. The tsunami impact mitigation role of vegetation remains a topic of debate in the literature.

**Objective of the research**

To better understand and assess the physical mitigation provided by tree crops as part of land-cover sequences in the 2004 Tsunami event in West Aceh, Sumatra (Indonesia).
The question with regards to the hypothesis of the present study was basically if creating a live barrier of trees with certain characteristics as suggested by several studies (Dahdouh-Guebas et al., 2005; Danielsen et al., 2005; Hiraishi and Harada, 2003) is actually a reliable way to reduce the damage inland in a tsunami event.

Overall, the contribution goes to the ongoing discussion of the most adequate way to develop a sound strategy to prevent casualties as well as the destruction of their production means in the event of a tsunami, and to determine if measures like the "building" of these live barriers are not generating a false sense of security as suggested by Kerr and Baird (2007) but rather hopefully being statistically significant in the prevention of a complete disaster, as the one occurred on December 26 of 2004. An overall contribution to food security is implicit by a better risk assessment and planning to avoid massive loss of subsistence means, mainly tree crops.

**Methodological approach**

To determine the influence of land cover present (especially tree crops) in the tsunami event, the area was classified so as to exclude off shore characteristics (peninsulas tips) and controlled for bathymetry and coastal geomorphology. Inland river areas (were flood seemed wider and more spread) were excluded. The use of processed satellite imagery became a fundamental part of the research for this classification and the latter input of georeferenced information.

Landsat landcover classifications developed by ICRAF were used as land coverage inputs. Each land-cover was assigned characteristics of "resistance" in a relative scale (e.g. rubber forest will have a 0.64 resistance compared to a mere 0.04 resistance coefficient for grass or a 0.0 resistance of open land). This values multiplied by the area covered by its corresponding land-use, gave a resistance factor, called "green roughness". Also topographic maps (DEM) were used to input elevation values to account for its effect influencing the tsunami wave.
To determine tsunami effects inland, three damage indicators were developed: run-up height, structural damage and casualties. Information related to these indicators was collected through the use of semi-structured interviews. These interviews were made in groups of local inhabitants of the communities, but also to key persons. Also during the interviews, one of the topics inquired was land cover change. This served as a way of information cross-check. All the interviews and the data collected were done using printouts of high resolution (Quickbird) images. This served also as a second way of data verification. The last data input and control was the use of previously collected information (NGO's, local government, reconstruction institution).

Later on, georeferenced information was introduced in transects, or sequential blocks of area. The information from this transects (damage indicators, elevation, and green roughness) was entered in SAS 9.1. Correlations and a regression model were attempted.

**Results**

The thesis was able to demonstrate important correlations between existing land-cover vegetation both in front and behind the human settlements and the corresponding casualties and damage to buildings. The positive effects of land cover in front of human settlements seem to confirm previous observations and allow a better characterization of their required properties. Different behaviors of land covers just tend to confirm this tendency and call for a more specialized research.

An important conclusion is that vegetation barriers should not only be effective in mitigation (e.g. mangroves) but also contribute to the economic benefit of local farmers: Traditional crops and tree crops are highly important production means in the area. Consequently, it is important to consider the whole livelihood system as an integrated tsunami mitigating arrangement, one that provides at the same time financial and subsistence means.

**Actual status of the research: How to apply the findings**

After the thesis was finished, the same dataset was used once more and a new finding appeared: the effect seen in the model tends to indicate that the bigger the resistance behind the community, the higher the casualty and structural damage. This is thought to be to the backlash effect of the retrieving wave.

Such a possibility has however important implications for land use planning in the framework of an effective hazard mitigation preparation. But before such findings can be used by local planning agencies, it is imperative to further investigate the underlying relationships. In order to generate a more generic and applicable model, additional input data and variables are required. The existing model is being currently enhanced through the following:

- A wider but still homogeneous (offshore characteristics) research area allows collecting more information and creating a more solid statistic structure as well as added information (if available) from different tsunami affected areas with different characteristics.
- Considering the existence or lack of escape routes as a determining factor for casualties will be a main new input.
- More precise land cover characteristics (measured height, width and density) allow for a better land cover (mainly vegetation) resistance factor to be developed.
- Incorporating process-based mechanisms from the physical wave modeling into the empirical model should lead to a more extrapolation power for the model to be applicable in tsunami-prone area under similar bio-physical and cultural contexts.
- The use of high resolution images and the development of a precise land cover change map allows to determine the changes due to the tsunami, giving a more clear idea of the effect of vegetation in the event.

Once improved the model the aim is to test it in a possible highly vulnerable area, most likely in the north Sumatra area. This should bring valuable information for the local inhabitants, consequently then also for local planners and decision makers. This has a direct impact on how people perceive their subsistence means, and how vulnerable can they be under false or not complete competent land-use planning.

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