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Assessment of physical mitigation provided by tree crops in the 2004 Tsunami event in West Aceh, Indonesia

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Introduction

The December 26, 2004 earthquake generated by the rupture of the fault boundary between the Indo-Australian and Southeastern Eurasian plates (Lay, Kanamori et al. 2005) is usually referred to as the largest seismic event on the planet over the last four decades (Annunziato and Best 2005). This rupture triggered a subsequent tsunami, an event that proved disastrous for many countries, especially for Indonesia with more than one hundred thousand casualties and hundreds of thousands displaced (USGS 2007), villages "erased" from the map and survivors living in relocation areas, rebuilding their lives away from the sea.

There are reasons to believe that coastal sites with presence of tree vegetation are markedly less damaged than areas without these in a tsunami event (Hiraishi and Harada 2003; Danielsen et al. 2005). Even though researches like these have led policies to establish "green barriers" along the coast of possible tsunami-hit areas, other studies suggest that the role trees played in the mitigation of the tsunami impact seems to be still not clearly understood, and this greenbelt protection effect may be giving a false sense of security to the coastal population supposedly sheltered by these barriers (Kerr and Baird 2007).

The aim of the present study is to contribute to clarify the role that green infrastructure, in particular tree crops, plays in case of a big magnitude event such as the 2004 tsunami. We will present data collected in the West coast of Aceh, in particular the Aceh Barat and adjacent coastal districts (Aceh Jaya and Nagan Raya).

Area description and damage assessment

A typical land cover sequence from coastline to inland goes as the following: Coconut garden -- Paddy Field/Home garden – Road/Settlement – Settlement/Road – Home garden/Paddy Field (or annual crops) – Rubber plantations (or forest) (Nugraha and Tumar 2006 and own observations).

In order to determine the mitigation provided by the land cover present, especially tree crops, we determine several damage indicators. We consider important to compare satellite land cover from before and after tsunami to determine changes in landscape. Nevertheless, our main indicators of damage are given by area flooded, run-up heights (both as measures of wave energy), casualties and damage to structures (as direct effects/consequences of mitigation/no mitigation by tree crops).

Field observations: Transects

Data collection structure is carried out along uniform study units: transects of land cover sequences built considering the following inputs:

- Flooded and damage area maps: Mostly determining an extent of 4 km per transect, consequent with the majority of flooded areas.
- Coastal Orientation: Equal or similar, not bays but rather straight shorelines.
- Near shore bathymetry: Mainly determined by coarse maps, showing no significant differences.
- Distance to major rivers: Avoiding extreme flooded areas which are close to big stream courses.
- Extent: 500 m wide transect and 4 km long (as mentioned above).

After considering the above mentioned parameters, 66 transects were selected.

Local information collection

After the transect determination, visits to the communities and interviews on site were done. The data collection for the research was carried out from April 18 until June 5, 2007. The method used was a semi-structured interview, focused on chiefs of villages, groups of inhabitants of the community and individuals part of the community visited. In cases when survivors were not in the community's original area due to relocation programs, interviews were made on these places. Later, information given in the descriptions was checked against high resolution images.

Model building

Once the wave is on land, the loss of its energy is depending basically on three factors:

- Distance (loss given by gravity and friction on flat areas with no land cover)
- Topography (geographical features issuing mechanical forces opposing resistance)
- Green Roughness (land use acting as a mechanical force opposing resistance)

Distance (d) is considered as the progressive physical loss of energy of the wave due basically to friction. This loss according to some studies (Massel et al. 1999; Hiraishi 2005) shows usually an inverse linear tendency. A distance correction factor is developed and used to correct Green Roughness and Topography.

Topography (T) is obtained by overlapping a Digital Elevation Model on the predefined transects and summarizing data based on the study blocks.

Green Roughness (GR) is the resistance offered by the land cover present at the tsunami event. It is constructed based on height, branching and density for vegetation of each land use in every block.

Village integration: For the research, the data collected on the study units (blocks) where villages were present at the moment of the tsunami are considered as the observation units. All the blocks that are in front (in direction to the shoreline) of these areas are offering "integrated resistance" to the wave, given by topography, green roughness and its interaction with the distance correction factor.

Results

Preliminary results presented will include an interpretation and description of land cover change due to the tsunami as shown by Landsat images based land cover classifications (produced by ICRAF).

The use of high resolution satellite images (QuickBird from Digital Globe, provided by the Pacific Disaster Centre) as ground maps and community references in an interview may prove useful if previous knowledge from the interviewer and good spatial orientation of the people interviewed are combined. As a future resource for information they have to be carefully understood. Many interviewed people, even though the image gathered their attention, certainly got lost on proportions and measurements while being asked about landscape details.

Nevertheless the use of this type of images as a cross checking source of information, for the field data as well as for the Landsat land cover classification map, has been extremely useful, enabling the researchers to verify and clarify doubts about land cover changes and precise distances to geographic features.

Concerning the statistical analysis, a model showing a first approximation to the interactions (and its significance) between the integrated independent variables, (showing the effect of green roughness and topography) and the depending parameters (casualties, run-up height and structural damages), is expected to be shown on the presentation.

The model explained should contribute with information on the possible mitigation effect that coastal vegetation, especially tree crops, in a land use sequence setting, may be providing to the communities living along the coast.

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