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Landscape Transitions: Integration of Pedagogical Approaches for Sustainability in Tropical American Mountain Communities

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Abstract

Tropical mountain communities are susceptible to natural hazards due to severe local landscape features. In addition, their peripheral network of disaster mitigation can be meager leading to population loss, not only from the death toll of catastrophic episodes, but also, by overall attrition due to failing socioeconomic ventures that fuel emigration. For sustainable development, ecological risk must be overcome in order to reduce vulnerability associated with uncertain social, political, and economic futures, thereby achieving a sustainable level of risk that will permit communities to exist in the long term. Educational efforts should include different pedagogical approaches that will better aid environmental interpretation of land use management and technological implementation of land-hazard analysis. This is the best way to understand landscape transitions, from isolated, unstable economies into a linked global production systems. As previous environmental awareness fades, a new paradigm should include sustainability consciousness—from an economic and ecological perspective—as part of a trend towards securing a reliable and respectable future for mountain communities.

Sustainability is a governmental responsibility that can be addressed through education of young generations that includes the promotion of policies which generate sustainable economic practices. Purely technological solutions to combat poverty may not provide long-term solutions if changes in attitude are not prompted at an early age in the schooling of mountain communities' youth. Without sustainability education, the highland exodus towards the lowland plains will continue to rise.

Keywords: Sustainability, landscape transition, hazard analysis, pedagogical approaches, tropical America.

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Introduction

Vulnerability to ecological risk continues to be a significant issue for communities in tropical American mountain areas, due in part to geomorphic, earth surface processes and associated management practices that continuously plague these communities with economic, social, and political strife (Alcántara-Ayala 2002; 2010). We evaluate the complex issues around the social, political and cultural paradigms that guide sustainable policy in mountain communities of tropical America. These concerns affect the livelihood of communities coping with steep, rugged terrain and the mass land-wasting movements on the hillsides. We will examine how ecological risk avoidance through sustainability education initiatives can reduce vulnerability and help mountain communities adapt as they move along the path of global environmental change.

Vulnerability captures the notion of intrinsic threats felt by inhabitants of the communities living in the demanding terrain of mountainous regions of tropical America (Adger & Brown 2009). Many people in these regions feel susceptible to disaster from external social, political, and economic forces that arrive from outside their local sphere of influence and greatly increase their vulnerability to ecological risk. Some may argue that these outside forces arrive under the rubric of environmental determinism that is unavoidable in these kinds of extreme environments (Henderson 2009; Sarmiento 2010). This notion—that the physical environment governs human activities—makes the vagaries of weather and climate principal determinants of the fate of mountain villages. Under this rubric, communities are destined to feel trapped in determinism as they deal with uncertainty and ecological risk (Brown & Damery 2009). To combat the rather fatalistic approach to confronting risk offered by environmental determinism, educators should adopt a change in paradigm to the opposite view of possibilism.

Tropical mountain communities are quite susceptible to all types of natural hazards due to active plate tectonics, climatic, and geomorphic features of the locale, including elevation, soil type, channelization, drainage, volcanic events, tremors and earthquakes, etc… (Figure 1). The vulnerability associated with the potential for these kinds of extreme environmental conditions brought on by drought, storms, mass wasting processes, earthquakes, and volcanic activities can be considered a principal driver for change in mountain communities (Mustafa 2009). However, as described by Sarmiento & Frolich (2002) in relation to the Andean tree line, several features of highland tropical mountains in the Americas have fuzzy boundaries between natural and anthropogenic. The 'naturalness' of the ecological risk is hence maximized when human drivers are included in the analysis. Furthermore, it is often easy to detect ecological risk on slopes where deforestation, trampling and road building have left their imprint (Myster & Sarmiento 1998) in a way that is easy to detect and map. Mapping for hazards thus becomes an important tool in the arsenal of risk prevention in tropical mountains. This kind of mapping then mitigates the disaster, suggests a reasonable response and helps reduce the force of vulnerability as a driver for community change (Harp et al., 2009; Harp et al., 2002). Land management and analysis (Ericksen et al., 2002), as well as sustainability and development for the mountain communities (Classen et al., 2008), all under human control, become more important elements. Maps also help communities understand ecological risk in the context of globalization of tropical American markets. They can even suggest alternate methods for revitalization and cultural affirmation. Teaching from maps is an invaluable strategy for visually grasping on complex issues. In

today's world, with the ease of access to internet-based mapping utilities, modeling sustainable future scenarios must depend, in part, on quality usage of maps (Herb et al, 2009).

Deforestation is another key reason why montane landscapes are vulnerable to the 'natural disasters' that continue to riddle both rural and urban mountain regions (Redo et al., 2009). Deforestation becomes apparent when forests are changed to another form of land cover and tree canopy level plummet below arboreal thresholds (Lambin et al., 2003), as illustrated by Redo et al. (2009) for Honduras, the poorest and most heavily forested (4,600,000-5,400,000 ha) country in Central America. Honduras and many other tropical American countries are hotspots of biodiversity and contain multiple ecological regions (Dettman 2006) that are sensitive to climate change, particularly in the cloud forest belt (Kappelle & Brown 2001). Incorporating mountain protected areas is important when trying to conserve biodiversity, thereby influencing policy and management (Zimmerer 2009) of shifting mosaics leading to positive change in landscapes affected by ecological risk. The implementation of mountain protected areas should take into consideration the "4 Rs" of the restoration ecology strategy: 1) to *reclaim* previously forested slopes, 2) to *recover* derelict lands, 3) to *revegetate* denudated slopes, and 4) to *rehabilitate* environmental services affected by continued disturbance or isolated disaster (Sarmiento 2000) . Through constructs like mountain protected areas, land use transition becomes an important function of political behavior, especially important in countries with volatile governments. When addressing these sensitive subjects of sustainable land management the key is to develop strategies that adequately foster and preserve the landscape and its livelihood (Ericksen et al., 2002) including mountain protected areas, buffer areas and rural farmscapes at large.

Land hazard analysis as an educational tool

For tropical America to provide protection and security to its mountain communities, governments will have to provide analysis of hazards that directly affect them in their mountain protected areas and at the local scale. Sustainable education modules should exhibit results of these analyses to make them usable for local population engaged in capacity building exercises. The pedagogical approaches, tested since ancient times to effectively build the capacity for enduring performance, are still a valuable tool for achieving sustainability, whether this be Egyptian (Ptolemaic approach with books), Greek (Aristotelian lectures, Socratic questioning or Platonic contemplation), Hebrew (Parabolic allegories), Roman (Deipnosophists conversations), Latino (satisfying sweat equity) or Native American (traditional knowledge). All of these approaches, working in tandem, can and should help illustrate and promote sustainability scenarios (Table 1).

The tropical American montane region is prone to environmental hazards that directly affect community livelihoods. One such hazard is mass movements and hill slope wasting, including rockslide, landslides, mudflows, lahars, floods, etc. Accurate and timely information through the use of Digital Elevation Models (DEM) and Geographical Information Science (GISc) produces cartographic outputs that can depict mass land movement scenarios. Using this kind of mapping technology, people can be engaged in learning disaster avoidance and mitigation, risk preparedness and overall awareness about a potential ecological risk. Much work has been completed since the aftermath of Hurricane Mitch brutally swept through the landscape showing no mercy for the people of Tegucigalpa and many other urban and rural communities surrounding the impact area (Harp et al.; 2009; Devoli et al., 2007; O'Hare et al.,

2005; USGS, 2004; Harp et al., 2002). Progress has been made in implementing a landslide-hazard assessment program that will allow for much more rapid response (Harp et al., 2009; Harp et al., 2002) and also secure sustainability for the mountain communities in the Mitch region. A landslide-hazard management program not only saves lives but it also allows the country to eliminate costly recoveries, ultimately saving millions of dollars that could be used revitalizing the economy of the country. Although many kinds of natural disasters affect tropical mountain communities, educational incorporation of land management analysis is probably the single most important component for decreasing the sense of vulnerability and environmental determinism that ensues from facing the ecological risk associated with disaster.

One of the main reasons Hurricane Mitch and other natural disasters have such great affect in Honduras and adjacent countries, is the severe topography and rugged terrain of the region (Harp et al., 2009; Harp et al., 2002). The art and science behind understanding landslide processes (USGS 2004) needs to be captured before identifying an appropriate management approach. The term "landslide" describes many processes that produce outward and downward movement of slope-materials including; rock, colluvium, soil, alluvium or a combination of these (USGS 2004) in the presence of water (alluvial mudslide) or without it (scree, rockslide). According to Harp et al. (2009, 2002) rainfall from Hurricane Mitch in Tegucigalpa totaled more than 281 mm/year, which was more than three times the amount of rainfall received from past hurricanes "Gert" and "Fifi". Hurricane Mitch triggered more than 200 landslides in and around Tegucigalpa (Harp et al., 2009; Harp et al., 2002) which can be used as indicators to determine the least stable slopes (Figure 2). Another methodology for indicating landslide susceptibility assessment was performed by Guinau et al. (2005) suggesting that landslide mapping is critical in determining instability factors of the landscape, such as slope and aspect. Guinau et al. (2005) also stated that performing comparison analysis between instability factors and zones of failure would provide appropriate data to determine future disasters.

By utilizing hazardous map analysis for landslides, tropical American countries like Honduras can educate their people on proper management and land zoning practices for building and construction purposes (Ericksen et al., 2002). Landslide mapping for hazards is a valuable tool for future land use planning and emergency preparedness, as was proven with the work of Hall et al (1999) and their mapping of volcanic risk of Mount Tungurahua in Ecuador. Manuel Guariguata (1990) showed that the method is also valid for assessing forest regeneration and understanding the response of the ecosystem to heterogeneous, periodical occurrence. Using these categorical maps will benefit the government in deciding how to invest time and resources for future generations to alleviate ecological risk associated with environmental hazards.

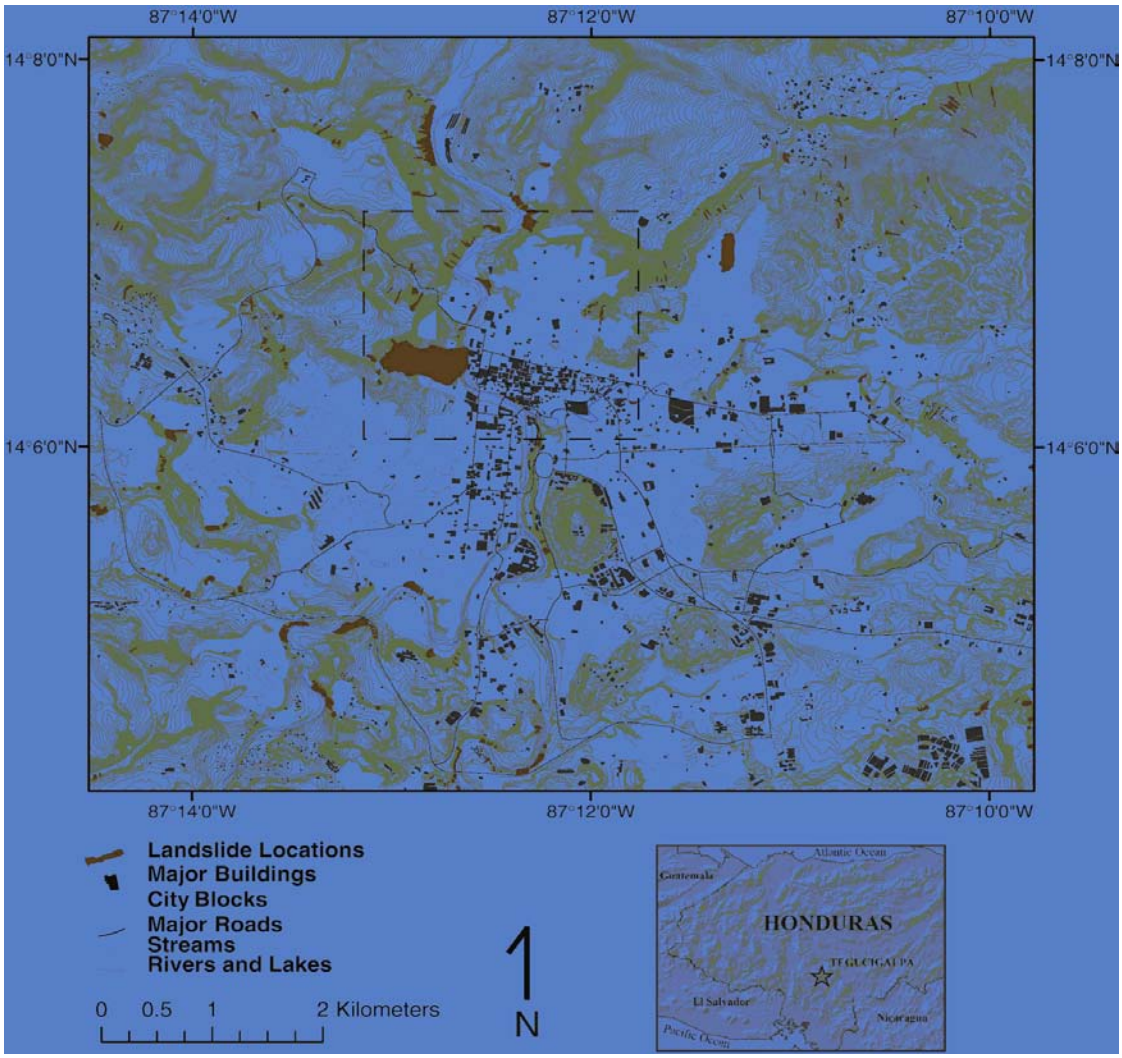

Figure 2 Inventory of landslides triggered by Hurricane Mitch in Tegucigalpa, Honduras (SOURCE: E.L. Harp et al., 2009; E.L. Harp et al., 2002)

Sustainability

Sustainable development horizons have been an extremely painful experience for the people of tropical America, especially when considering social and political agendas. One of the reasons that sustainability has been such an issue is because of enduring climatic and environmental extremes in tropical mountain regions. It is certain that Honduras will have disastrous weather and damage due to the ill effects of climatic conditions in the future. Another vulnerability factor that impedes development is the economic struggle that poor mountain peoples continuously face (Carter et al., 2007; Morris et al., 2002). Whether it is land issues, social reform, inequalities, or a combination thereof, impoverished communities cannot seem to forge ahead.

Sustainability is a way to meet the needs of people and their environment that captures the essence of well-being without harming ecological reliability in the future (Mansfield 2009). Sustainability also provides the socioeconomic capacity to solve political problems related to the mountain environment. One way to incorporate sustainability and development objectives is by implementing strategies and policies that protect valuable natural resources in tropical countries. Honduras has been able to take advantage of this concept by integrating the Mesoamerican Biological Corridor (MBC) into national policy (Dettman, 2006) as an exemplar of a "bioregional planning process". The Mesoamerican Biological Corridor (Figure 3) has two major goals: preserving biodiversity through connected protected areas and supporting sustainable economic development (Dettman 2006).

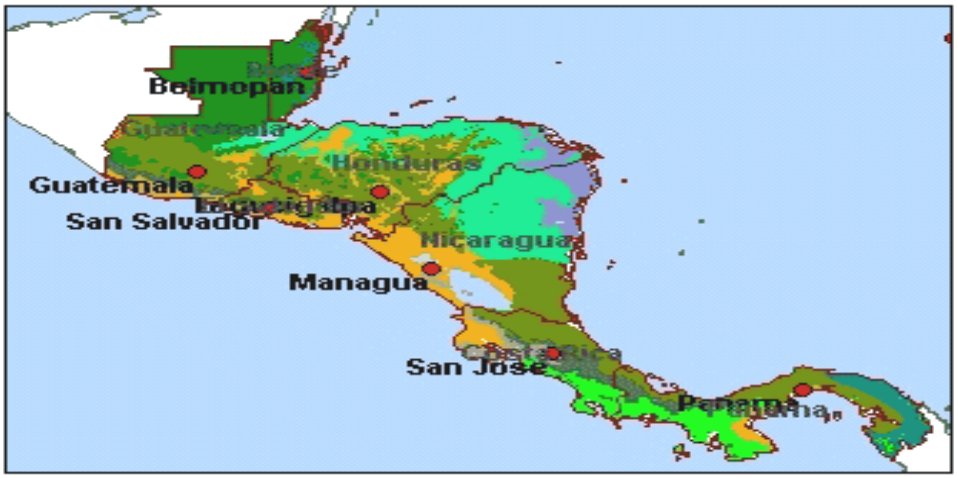

Figure 3 Mesoamerican Biological Corridor. Adapted from Dettman 2006.

Many different factors need to be engaged in managing and sustaining the corridor areas. It will continue to be a challenging road ahead administering a system as complicated as the Mesoamerican Biological Corridor, which connects across eight countries, each with contrasting views and policies, while at the same time encouraging local economic development (Dettman, 2006).

On a global scale, the planning of sustainability becomes critical relative to the particular path of development that is chosen (Cortese 2003) whereas education preserves the notion that environmental issues are not just linked to the capitalist markets, but that they provide solutions to injustice, inequality, poverty, and land degradation (Mansfield 2009).

Landscape Transition

Past environmental education campaigns were geared towards the awareness of the physical impacts on natural elements such as flora and fauna. While biodiversity of wild places became the paradigm for protection and ecology became the science of the interaction of the elements in the ecosystem, new developments are now in place. Currently, sustainability education incorporates intangibles associated with the cultural landscape, including people's livelihood, potential cultural reaffirmation, ecological risk and even resource distribution and

technology. This makes Political Ecology the science of decision making for how elements are allowed to interact in the ecosystem. In tropical mountains, examples include the notion that rain forests are the least productive agricultural landscape. And valleys should be destined to pastureland or urbanization, because slope lands with forests are abandoned due to neglect.

With the use of statistics-based geographic tools, Monroe and Miller (2007), landscape analysis techniques are becoming popular for their ability to investigate future risks associated with a particular landscape transition, such as forest clearing (Figure 4).

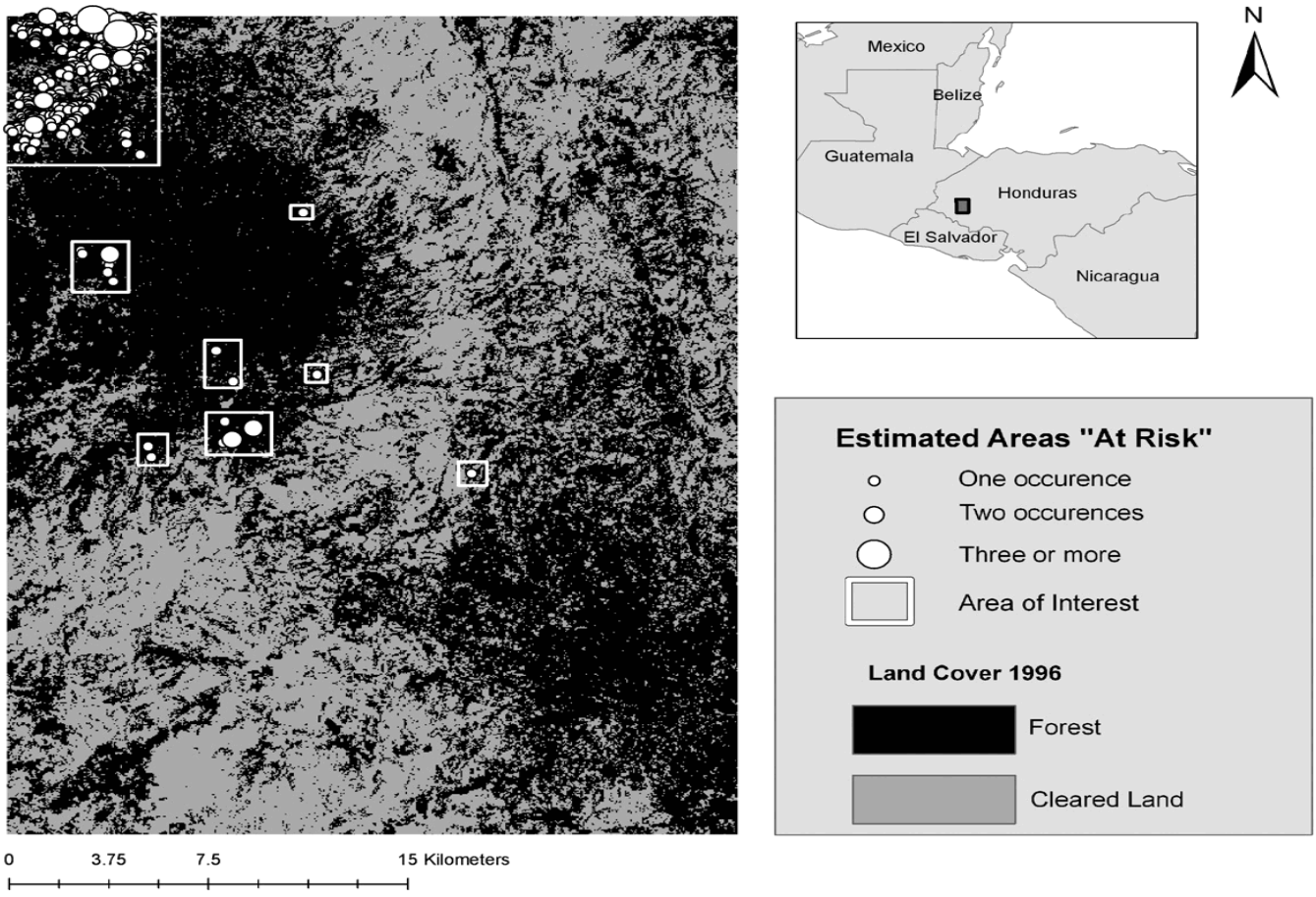

Figure 4 (Source Munroe and Miller, 2007) Estimated areas at risk of forest clearing

Pfeffer and others (2005) argue that there is competing demand for land use with increasing population in Honduras, along with the governmental efforts to conserve natural resources. A case study of the Cerro Azul Meambar National Park (CAMNP) by the Honduran government looked into different land use initiatives that dealt with certain restrictions on resource use of people living inside park boundaries (Pfeffer et al., 2005). As seen in the diagram below (Figure 5), there are six major catchment areas within CAMPN that are of great interest to the Honduran government because of their economic and political importance (Pfeffer et al., 2005).

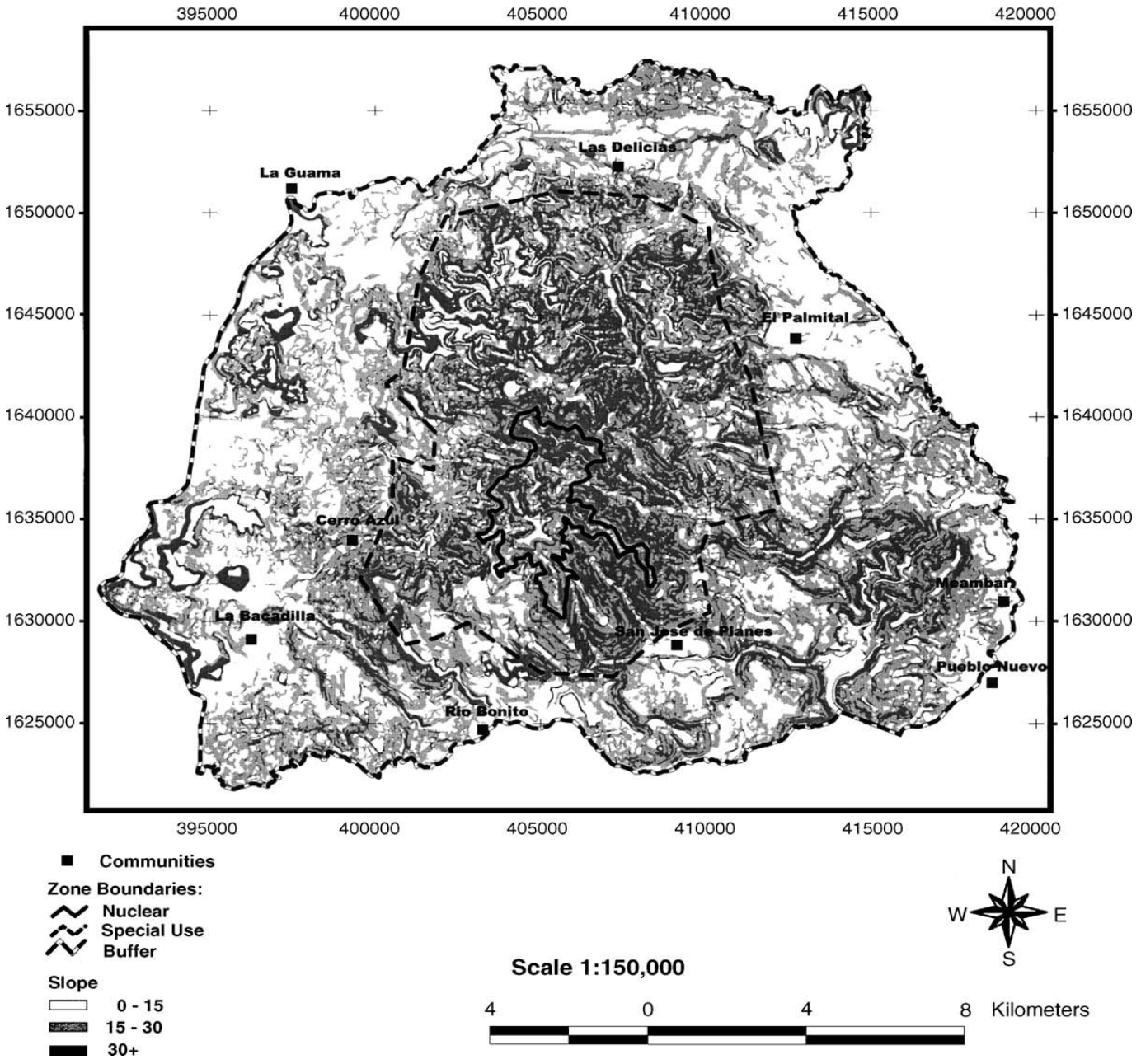

Figure 5 (Source Pfeffer et al., 2005) CAMNP and classification by degree of slope

Because of the steep slopes and the terrain of the park, agricultural opportunities are significantly lowered and trying to plow the land is difficult (Pfeffer et al., 2005). Many different techniques and patterns of land have been identified. However, the local population and their educational formation, is the one driver that has to be maintained or controlled if Honduras will be successful in implementing management policies quality land use into the future (Kok 2004).

Pedagogical approaches

It is useful to have access to geographic tools and techniques for land analysis and, and thereby prepare maps of ecological risk to be used as didactic materials. However, the level of affluence in school systems and among families living in the mountain communities rarely allows for access to these techniques and tools. Therefore, traditional educational approaches have to be considered before implementing a change in educational paradigm that incorporates sustainability in such a way that learning outcomes can be incorporated into daily teaching practices in mountainous areas. We propose that professors and other professionals working in tropical mountain communities should use at least four of the following nine pedagogical approaches to affect positive change in the attitude of students learning about their future:

Aristotelian method: New lectures on recent discoveries or changes in the curriculum should be impacted by the teachers as the new information becomes available, hence, updating and optimizing the repertoire of class materials towards sustainability.

Socratic method: Questions about the environment and the mountain livelihood should be enunciated to initiate a debate of facts and opinions prevalent in the communities affected by risk. By providing feedback to students' questions, the teachers will likely increase their own understanding of the vulnerability of the site and this, in turn, will prompt new information flow.

Platonic method: There must be a level of commitment with either the study area or with the subject matter that brings the educational process to an evocative, personal level, requiring each student to identify and care for it with enthusiasm, respect, even love, for only when you love your place you will care for the long-term maintenance or transcend into improving the future.

Ptolemaic method: The passion for reading and learning from accumulated pages of references, encyclopedias, dictionaries, textbooks or any other trusty source of information on environmental topics that should be used to create a library for communal use, allowing access to published materials and developing the habit of assiduous readership.

Melchizedekian method: The decisions that students must take from the rush of uncertain outcomes appear without planning, as if they were destined to happen, often, guided by omens that motivate the next step. Uncertain outcomes help affirm convictions that prompt dialectic understanding of the choices at hand, making sustainability a reflection of consumerism by maintenance instead of by growth rate.

Parableic method: Students should be exposed to stories that compel by comparison with current environmental problems, such as, allegories of far-reaching destinations, or fables of mythical heroes for environmental amelioration. These tales that illustrate, by local example, inspire spiritual connections with the mountain landscapes.

Deipnosophist method: The fact that the body nurtures the mind should be taken as an opportunity to have conversations and other didactic moments at the table with students, whether in breakfast meetings, lunch sessions, mid-afternoon breaks or traditional dinners, where learning about sustainable futures is done with fun debates, happy overtones and nutritious food.

Latino method: Applying the admirable endurance of hard working peers, liberal thinkers, and questioning students can be asked to go an extra mile in hands-on assignments, group-based

skits, and mock presentations about environmental issues affecting the community. These presentations, above and beyond the call of duty, form a lasting impression and meet a viable learning outcome, easy to remember and retell to others.

Native American method: Making the effort to learn through the realization of mistakes in ceremony, storytelling and song, or the sheer learning of making hunting mistakes so students will not do them in the real world, often following the advice of mothers or wise men clues, observing clues that could provide inspiration in pursuing new options to cope with situations that the elders could not readily identify in the environment.

Culture	**Exponent**	**Description target**	**Example**
Greek	Aristotle	Lecturing to an attentive crowd	Formal classroom lectures and speakers
Greek	Socrates	Questioning to the naïve crowd	Debates and discussions, colloquia
Greek	Plato	Contemplating the affectionate crowd	Poetry assignments, art contests
Egypt	Ptolemy	Reading to the illiterate crowd	Library searches, librarian talks
Arab	Melchizedek	Conjuring the superstitious crowd	Storytelling, tricks, prestidigitation
Hebrew	Jesus of Nazareth	Parableing the religious crowd	Storytelling, fable reading, show-and-tell
Roman	Ulpian	Deipnosophisting the hungry crowd	Lively conversations around a meal
Latino	Andrés Bello	Enduring the tireless crowd	Effort and sweat equity in educational tasks
Native American	Rainbow Eagle	Fableing the younger crowd	Song and dance; Traditions

Conclusion

We reiterate the need to include new pedagogical approaches for teaching traditional subject matters, updated for sustainability education. The role of critical cartography and deep community involvement should be impressed upon students early in their progression. If the use of maps, and their interpretation for disaster mitigation, becomes a staple of formal education, future citizens will show a lot more environmental awareness and commitment to maintain, if not improve, their livelihood in tropical mountains. A larger effort should be made by Non Governmental Organizations (NGOs) and regional or international funding organizations to incorporate sustainability education as part of the curriculum requirement for high school graduation. With a plethora of didactic approaches to emphasize vulnerability and adaptation to global change, the future generations of tropical mountain residents will be better prepared to cope with their changing landscapes.

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