Naturalness as a Paradigm for Environmental Services Assessment

Martín Alfonso Mendoza B., Ana Lid del Angel P., and Gabriel Díaz

Abstract—*The municipality of Coatepec, Veracruz, Mexico, has been the first in Mexico to set up a purse and a payment scheme to pay for environmental services. The scheme at Coatepec focuses on water resources, though many other similar programs exist throughout the world. Here a theoretical analysis permits to study and understand the dominant effect that position and arrangement play in the relevance of specific forms of land cover and stand structure in regard to a differential importance to overall level of environmental quality that society enjoys. The driving force that makes a difference in the importance of a specific stand is the degree of resemblance to pristine conditions in its structure and functions, modified by the strategic position on the ground respect resource position and users location in the watershed. Attributes of natural conditions were inferred from landscape ecology theory, and from historic records from the region. These attributes are then converted to importance values for a catalog of current conditions present in the region, and applied over a land classification map. Value estimates are drawn from an arbitrary scale that can be translated into a certain payment for environmental services rendered. These latter translation requires a definition of a specific purse of public money, or else, a theoretical estimate of service demands from stakeholders and affected regional population. The estimate of environmental services value is presented in a map and a payment scale in tabular form, for conditions in the Coatepec municipality in 2002.*

Introduction

This paper deals with the relative importance that position provides to environmental relevance of cover types and structure. Although it is natural to accept that spatial arrangement is an important factor that modifies the role and weight of those elements that constitute environmental quality, applications such as valuation of environmental services generally portray poorly this hierarchic strategic importance. Using a case study, a specific instrumentation is presented. This design uses a measure of naturalness weighted by public preferences and relative position to segregate which areas contribute the most to environmental quality.

Environmental quality, in the context of this paper, is the subjective perception about personal welfare associated with human environmental condition. As such, a hierarchic scale derived from public preferences is a suitable device to generate a value scale to use in land classification.

Forest continuity as measured by fragmentation statistics is one of the principal expressions of geographic differentiation. Feasibility of self-sustaining populations requires sufficiently large gene pools that move around genes freely. Considering trees as the most demanding of populations, it is convenient to think about genetic feasibility in terms of terrain covered by a continuous tree canopy. Besides serving as a proxy for most species genetic pool, continuity in canopy also represents a number of important ecological functions and environmental influences, such as watershed regulation of water flow, and soil stability.

Edge effects also have been a matter of attention in landscape ecology because they are seen as detrimental of the productive performance of timber stands. However, edges between wooded areas and open ground are gradients that create an interphase between contrasting environments, and as such, they represent a valuable storage of opportunities and diversity in wildlife habitat, and ecological influences in the interface between forested and open ground. Careful handling of opportunities and hazards in edge environments is one new priority in forest management that resulted from advances in landscape theory.

The global trend to achieve social efficiency in environmental services markets has developed in Mexico into a scheme where government sets up arbitrary sums of money to allocate as subsidy for those landowners whose properties contain specific vegetation covers in good natural condition. Since stocking, composition and other spatial independent attributes are used as criteria in selecting whose land deserves subsidy, no consideration

is given to landscape factors such as fragmentation, connectivity, edges, and strategic position. In this paper a contention is made that similar pieces of land will have contrasting weight over the amount and quality of the most important environmental services, depending on its position, extent, amount of edges, and chances for connectivity. Water is the resource that this study uses as example because it is also the resource whose services are the foremost presence in the public mind, and in the government declarations.

The design presented is a scheme that assesses environmental quality of pieces of land judging the presence of characteristic elements expected in natural conditions, weighted by position in the watershed (highlands being more influential), nearness to water and riparian zones, continuity in canopy (best if <10 000 ha, and >50 ha), minimal edge condition, near other wooded blocks (<200 m). Weights are defined subjectively, following hierarchic preferences of the local public.

One study case, the municipality of Coatepec, Veracruz, is presented as example, and as a means to explain the scheme and its properties and capabilities. Coatepec is a small municipality (around 14 000 ha), just 20 km away from the state capital of Xalapa, is part of the most important coffee producing region of Mexico. The mountain range of Sierra Madre Oriental gives Coatepec a mountainous setting with steep valleys descending on the Golf of Mexico's coastal plains. Coatepec is the first place in Mexico to introduce a program of subsidies for environmental services, and its peculiarities are favorable to research because they display many different vegetation types, degrees of land development, and steep topography that offers varied resource scenarios, from supply of water for cities, an irrigation district, water sports and fishing, channel stability upstream, and flood hazards downstream.

Methods

A land elevation model and vegetation classification was taken from INEGI. Public opinion was gathered though a survey of random interviews using a fixed response questionnaire. The questionnaire uses non monetary valuation questions to elicit the interviewee choice of preferences regarding environment, and public spending on environment related programs. Finally, description of current structures and condition for all cover types present was obtained by sampling random points along regional transects, and measuring and registering specific attributes of natural and developed conditions for a given land cover type.

Definitions

Natural cover types:

- Temperate mixed conifer forest
- Cloud forest
- Medium tropical forest
- Low tropical forest.

Developed conditions and transformed cover types:

- Temperate forest: prairie, grassland, homestead
- Cloud forest: coffee plantation, cultivated grassland, city, town, rustic residential area
- Medium tropical forest: fruit orchard
- Low tropical forest: intensive cropping (sugar cane, produce), annual cropping (corn), grassland, town

Seral stages of natural vegetation:

Mapping criteria adapted from Oliver and Larson (1990):

- Initiation – One story, no crown differentiation, any age, but usually young pre-reproductive, little or no fuel load.
- Exclusion – One story, crown dominance, some density related mortality, some fuel load of fine fuels, any age.
- Reinitiation – Two stories, some medium to large openings, some fuel load, some snags.
- Diversification – More than two stories, all sorts of openings in diverse stages of regeneration, considerable levels of fuel, some large woody debris but seldom fully degraded, many snags, rare catastrophic events but many and frequent small disturbances, many large trees, some reaching maximum longevity.
- Old growth – Large and old trees, numerous small disturbances with regeneration of every possible age, large accumulation of sizable woody debris, all fully decayed including large snags heart rotten, topped.

Special Conditions

- Riparian zone
- Roads, trails, highways

Assessment

Transects across the region permitted sampling of all cover types and the variability of their conditions. Area contains not enough repetitions or ample zones of a single cover and condition, so sampling was selective with criteria emphasis on representivity, spread of distribution, and the inclusion of as much variability as it could be detected during a preliminary survey.

After selective choice of a location in a given transect, sample point was randomly selected within the

apparent extent of continuous cover of the same kind. All conditions of the cover present at the sampled location were sampled, whether they were seral stages, defining attributes for the cover and condition, and special conditions such as houses, cities, or other man made structures, stretches of dirt or paved roads, and segments of channel and riparian conditions. When more than one special condition was present, or if enough length of linear conditions, randomization defined the sample position.

Point variables were measured or registered at the sample point. Area measurements were taken from a relaskope plot centered at the sample point. Length observations and measurements were taken in stretches of 20 m of road or stream.

Field data was summarized. The list of values in a cover and condition combination constituted its description for purposes of land classification and assessment of environmental quality. Each polygon with a given cover and condition was given a relative value of 1 if it were in a natural condition, more than 50 ha in area, less than 2 times the perimeter of an equivalent circle in edges, had at least 5 % of small openings inside, was inside a riparian area, and in the upper third of the watershed in elevation. Weights reducing the initial value were added for each factor missing. Weight value sought to create a spread of values representative of the observed variation in that criterion during the field transects. Developed and damaged sites were evaluated according to the apparent suitability of the current condition for providing a similar effect as the natural covers; for instance, city environment is judged as an efficient cover for regulating the water resource, while annual crops are highly ineffective in the same way.

Valuation

A photo mosaic with images depicting characteristic elements of most local cover types and conditions was presented to a random sample of persons in the locality. Randomization was done by home or work location. Control responses were taken from a set of scientists and government officers, and a set of persons randomly selected at the state capital of Xalapa, a large city 20 km away of the study area, and a community with extraordinary leverage in land management policies and decisions in the region. Sampled individuals were asked to identify which images are the most natural, which they felt provided the most environmental services, and which of the environments represented they liked best, or would like to see in their region. Then, they were asked their opinion and assessment of government spending in environmental programs. This question was paired to the respondent's expressed need for a better environment, if any.

Considering that the local and national government already is allocating a certain budget for environmental programs, the relative share for Coatepec can be considered as a purse that is to be divided among those landowners possessing land that provides or protects environmental quality. With this thought in mind, the level of public funding could be divided by the study area and then multiplied by the relative worth factor previously estimated.

Results

Survey results indicate that there is an overwhelming satisfaction with the current level of environmental quality in Coatepec, and therefore, the public sees no need to increase government spending, nor pass on the cost of environmental services and externalities to businesses, farms, nor consumers. Additional verbal comments from some interviewees explain that the only environmental concern at this point is the need for government to assure no additional environmental degradation, nor land development of any sort. These results can be interpreted as an unwillingness to pay for additional environmental services or quality. See the geographic distribution of cover classes in figure 1.

The total study area involves 69223 ha, practically all of them in a single watershed drained by La Antigua river. Forested area is 4452 ha, split into 1004 fragments of up to 214 ha; only 31 fragments (998 ha) can be considered functionally as forests. Coffee plantations and other orchards with forest like functionality occupies 5111 ha, while other agriculture and animal production uses 22204 ha. Urban development has used an additional 3793 ha. Considering a 200 m buffer zone, riparian conditions add up to 1857 ha, but only 727 ha are forested and they contain.

In all the study area only one polygon had a relative worth of one, and two had a greater than 0.9. The rest are fragments of vegetation away from riparian or highland conditions, and therefore unlikely to seriously enhance the region's environmental quality, therefore, it would be socially inefficient to pay subsidies to these landowners until they, could change their land management to a more socially responsible manner.

Persons interviewed were asked if they could identify the cover type, assess the degree of good or bad environmental condition, and finally, express their relative personal preference.

Data sampled included verification of cover indicators, as defined above. Then elements defining naturality were listed in each locality.

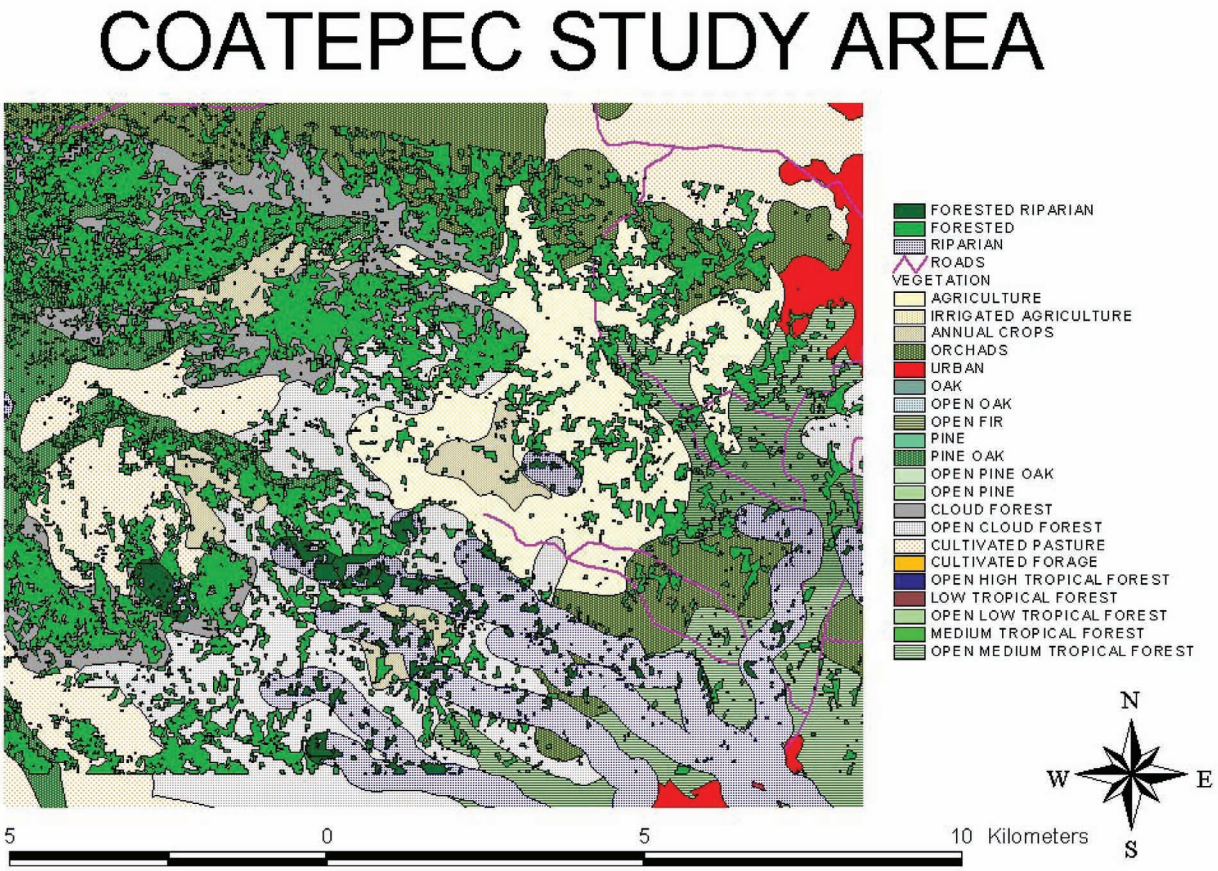

Figure 1. Coatepec study area forested fragments and vegetation cover types.

Cover Distribution

Potential cover (natural) is assumed to be as defined by INEGI (map of veg. cover).

For each polygon in the map was estimated area, net area deducted from edge effects (a 30 m buffer was assumed), and distance to the closest polygon of the same cover type. Valuation in the previous phase was weighted subjectively in a 0 to 1 scale to consider deductions if polygon net area were less than 50 ha. If a polygon had less than 50 ha, the area of all polygons of the same kind within a 200 m distance were added before deducting the weight.

References

Oliver, C.D., Larson, B.C. 1990. Forest stand dynamics. McGraw-Hill, New York, USA 467 p.