Land moves and behaves:indigenous discourse on sustainable land management in Mexico

ZINCK Alfred (1) **and BARRERA-BASSOLS Narciso** (1,2)

(1) International Institute for Geoinformation Science and Earth Observation (ITC), Soil Science Division, PO Box 6, 7500AA Enschede, the Netherlands
(2) Instituto de Ecología A. C., Departamento de Ecología Vegetal, km 2.5 Antigua Carretera a Coatepec, 91000 Xalapa, Veracruz, Mexico

Abstract

An ethnoecological study was carried out in the Purhépecha community of San Francisco Pichátaro, West Central Mexico, with the purpose of investigating how land degradation, in terms of soil erosion and fertility depletion, was (and still is) handled by indigenous farmers so that traditional agriculture could remain sustainable over centuries. The indigenous concept of land is discussed as an integrated whole, including water cycle, climate, relief and soils. Indigenous people venerate land as the mother of all living beings, including humans. Therefore, people's health and survival require good land care and management. Local knowledge on land management is organized around four basic principles: land position, land behavior, land resilience and land quality. Farmers recognize land as a dynamic subject, a concept reflected in the expression "land moves and behaves". Soil erosion and fertility depletion are perceived as "normal" processes the farmers control by means of integrated management practices. Farmers recognize several land classes, primarily controlled by landscape position, which require different land care. The example of San Francisco Pichátaro demonstrates that traditional agriculture does not necessarily lead to land degradation. But the collective knowledge, or social theory, on land management is increasingly exposed to be fragmented as the community undergoes structural changes and looses its social cohesion under the pressure of externalities such as off-farm activities, out-migrations and governmental intervention, among others.

Keywords: ethnopedology, indigenous people, local attitudes towards soil health, local land use systems, mountain landscapes, Mexico

Introduction

Land degradation in Latin-American highlands is often perceived as resulting from inadequate land management practices implemented by local farmers living in fragile landscapes and exploiting marginal soils under strong climatic variability. In contrast, recent ethnoecological studies show that indigenous land management systems have been sustainable over long periods of time, thanks to (1) their adaptability to political, economic and environmental uncertainties; (2) their flexibility to change, allowing for partial adoption of innovations; and (3) the development of strategies that maximize land use in space and time via diversification of crops and practices, while minimizing the use of external inputs. However, indigenous production systems are increasingly vulnerable to the effects of globalization and are therefore at the crossroads of sustainability, because the introduction of new farming practices often causes land degradation to increase.

We have carried out an ethnoecological study in the Purhépecha community of San Francisco Pichátaro (4,500 inhabitants), Pátzcuaro lake basin, Michoacan state, in West Central Mexico, with the purpose of investigating how land degradation, in terms of soil erosion and fertility depletion, was (and still is) handled by indigenous farmers so that traditional agriculture could remain sustainable over centuries thanks to co-evolution of eco- and socio-systems. This paper is derived from a case study including a semi-detailed geopedological inventory, an analysis of farmers' soil-land knowledge using an ethnographic approach and participatory workshops, and data integration in a GIS.

The study area is a volcanic landscape, formed by Plio-Quaternary basalt cones covered with pyroclasts and separated by small valleys, between 2,300 and 3,200 m.a.s.l., along a bio-climatic gradient shifting from temperate sub-humid to cold humid as elevation increases. The presence of fertile volcanic soils and permanent springs contributed to make Pichátaro an early center of maize production. Although land occupation started 2000 years ago, there are no conspicuous soil erosion features and significant evidence of land degradation (Barrera-Bassols, 2002).

The Indigenous Concept of Land

For indigenous people, land has a symbolic meaning based on Meso-American beliefs blended with practices from popular Catholicism. In this context, land is perceived as a resource, which behaves as a living being, and as a life support system for humans. Land, plants and humans are bound by reciprocal relations, which allow perpetuation of life on earth. Land is venerated as the mother of all living beings. Cropping and crop harvesting are seen as basic activities securing people's health and survival, and require thus good land care and management. These ethical values support all local production activities. However, people consider and accept that this belief system is exposed to and can be altered by economic and environmental uncertainties, which means that land's behavior cannot be totally controlled by people living on it or working it. Thus, humans are bound to land and have to conjure its benevolence through respect, compromise and tolerance. This is reflected in the relationships between climatic cycle, production cycle and ritual calendar. The relationships might transcend the strict community sphere and take into account externalities, which affect the internal relationships between generations and between individuals, such as temporary out-migrations and off-farm incomes. Therefore, land care, sustainable productivity and conservation are inherent parts of the symbolic land concept. This is then reflected in the way land is managed to meet human needs, without damaging the resource potential and thus the life support system provided by land. In a fashion very similar to the modern land concept (Zonneveld, 1995), land is viewed as an integral whole, including water cycle, climate, relief and soils.

Water cycle

Pichátaro's farmers have acquired from experience good knowledge of the water cycle, because agriculture is fully rain-dependent, weather is highly variable in space and time, and crops are exposed to unpredictable occurrence of frost and hail. The behavior of clouds, the direction and intensity of winds, the moon cycle and the position of Venus are used as meteorological indicators with influence on plants, animals and humans, as in other mountain communities of the region (Motte-Florac, 1997). Particular importance is given to the moon cycle, which controls the rhythm of farming activities, forest exploitation, and gathering of fruits and mushrooms. Full moon (Nana kutsi huiniri uiripiti) is considered an appropriate time to harvest maize and extract wood, which are dry by then. In contrast, planting fruit trees and castrating animals take place during new moon (Sapichu kutsi huiniri), because the body of living organisms is well provided with water at that time. Sowing is discouraged during increasing moon (andarani shatia) because of excessive moisture, which favors pests and diseases.

Climate

Farmers distinguish four temperature periods, coupled with three rainfall periods during the year. Special attention is given to periods and meteorological events critical to cropping, such as timing and intensity of the first rains, summer drought, hailstorms, frost and snowfalls, in a fashion similar to the one of African small-farmers. They also recognize, and take into account for land use planning and farming, three bio-climatic elevation zones, including (1) very cold and very humid, (2) cold and humid, and (3) temperate sub-humid. Local combinations of elevation, aspect and vegetation are used to identify micro-climatic niches and areas prone to environmental risks, including flooding, hail, frost, snow and whirlwind. This practical knowledge is embodied in farmers' mental maps representing the micro-climatic fragmentation of the landscape.

The periodic occurrence and level of severity of climatic risks are predicted from inter- and intra-annual climatic variability. Because the territory of the Pichátaro community lies mainly above 2,400 m elevation, the most feared climatic risk is late frost. White frost (Iauaka urapiti) on the surface of the soil is less damaging than black frost (Iauaka turipiti), which penetrates the soil and affects crop roots.

Farmers use a counting system, common among Meso-American people, to forecast climatic conditions over a full year from the weather conditions in the first 24 days of the month of January in the ongoing year (Katz, 1997). The weather observed during the first 12 days of January is used to predict the basic climatic regime of the 12 months of the year, amended in opposite sequence on the basis of the observed weather during the following 12 days. Further improvements are introduced from the direct observation of meteorological phenomena, as well as from the behavior of plants and animals. Climatic conditions assessed by farmers coincide fairly well with the meteorological data recorded by the station closest to Pichátaro. Farmers are used to react to small rainfall variations during critical periods of the plant development cycle, using local variations in elevation, topography, aspect, soil type and crop variety.

Relief

Farmers usually segment the relief in "up" (high), "intermediate" (middle) and "down" (low) according to topographic position. This allows them to recognize the spatial distribution of erosion and sedimentation by water during the rainy season and by wind during the dry season. Criteria such as slope, aspect, position, surficial lithology, and adjacency or connection to other relief types, together with anthropomorphic terms such as head, breast and foot, are used to describe the configuration of the relief. Additional attributes are implemented to describe the shape of the topography (flat, concave, narrow, etc.) and the degree of dissection. The relief is described like a toposequence or catena, in its structural and dynamic content, for practical purposes of slope management (Bocco and Pulido, 2001). Each relief unit or slope segment is given a local name, which summarizes the environmental conditions and the farming practices required. Farmers clearly appreciate the beneficial effect on soil fertility by the volcanic ash spread on the soil surface during the Paricutin eruption in the early 1940s.

Soils

The word "echeri", used by Purhépecha people to designate the soil cover, is in fact polysemic and refers at the same time to soil, land, landscape, terrain and bio-climatic zone. Thus local people perceive soil-land as a multidimensional component of the landscape *sensu lato*. When referring to soil types and properties, the farmer conceives soil as a tri-dimensional body, similar to the technical concept of soil. When concerned with farming practices, the farmer uses "echeri" to designate a bi-dimensional land surface, with variable management requirements according to local bio-climatic conditions. Beyond this practical relationship between farmer and soil-land as a resource, there is a symbolic relationship by means of which farmer's land care is rewarded by the land providing him with goods and services, including food, materials for construction and ceramics, as well as medical, ritual and magic uses.

Local farmers recognize five major soil types: (1) dusty soils (echeri tupuri), (2) clayey soils (echeri charanda), (3) sandy soils (echeri kutzari), (4) gravelly soils (echeri tzacapendini), and (5) hard soapy soils (echeri querekua). Soils are further subdivided in 15 subtypes and eight varieties on the basis of textural and color differences in the upper 45 cm. Additionally, farmers distinguish composite soils at plot level as textural or color intergrades, e.g. dusty-clayey soils (echeri tupuri-charandani) or dusty black-yellow soils (echeri tupuri turipiti-spambiti). Intergrades are related to their position on the landscape, the adjacency to neighboring landscape units, the intensity of sediment transit and the volume of debris accumulation.

Land Management Principles

Four principles organize the local knowledge on land management: land location, land behavior, land resilience, and land quality.

Land location and properties

Land characteristics and suitability vary according to the position on the landscape. Five main landscape types are recognized, including summit and shoulder areas, mid-slope positions, footslope positions, valleys, and lava-flow plateaus (Figure 1 and Table 1).

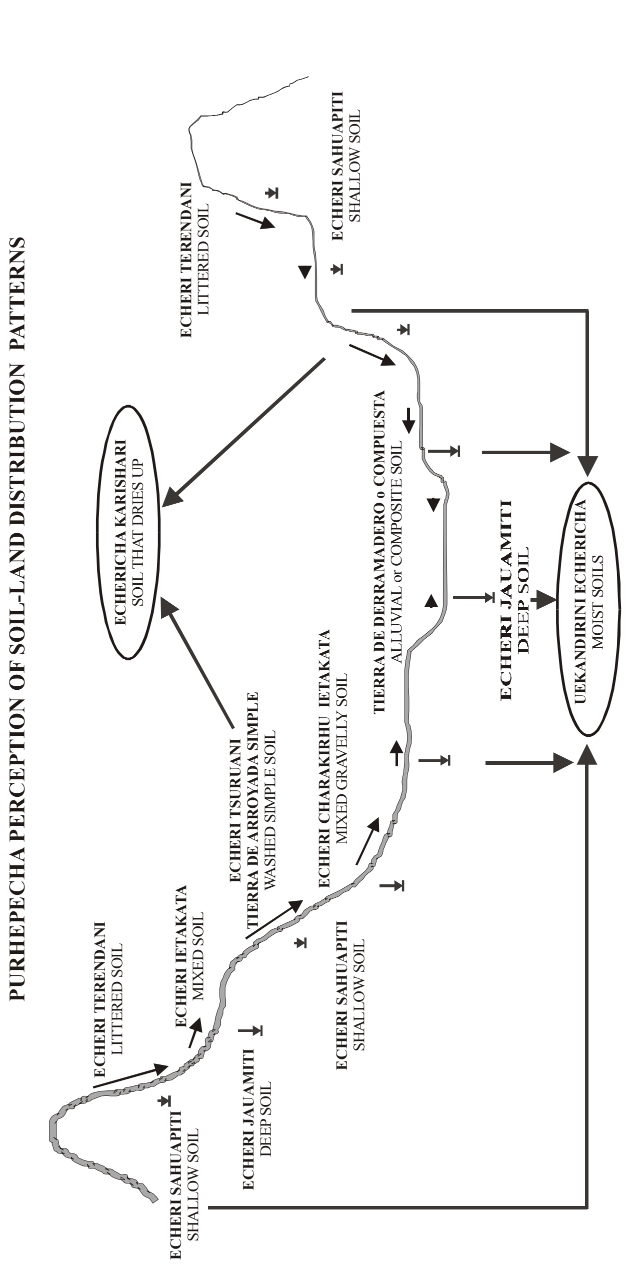
(1) Land in summit areas (teronstakua) and on steep slopes (sanish unanagaristi) is called "rotting" land because of the decomposed litter covering the soil. Soils are shallow, dark, silty or powdery, loose, always moist and resistant to erosion under forest cover. The weathering products move downslope and enrich the soils located on footslopes. These soils are called echeri tupuri terendani (Pachic Melanudands). The land is good for forest use but not for agriculture. It is neither "cold" nor "warm".

(2) Land in mid-slope positions is referred to as hill-breast land (terongarikua). Farmers recognize that soils in backslope areas are exposed to runoff and vary at short distance from shallow and single-layered to deep and multi-layered. The first ones are considered "cold" and the second ones "warm". Together, they are called echeri tupuri spambiti ka echeri tupuri turipiti-spambiti (Typic and Humic Haplustands). In farmers'

opinion, this type of land has low “strength”, dries up very fast, requires special care and long fallow periods, but is nevertheless suitable for agriculture.

Table 1 purhepecha soil terms.

PURHÉPECHA TERM	ENGLISH TERM	SPANISH TERM
Echeri sahuapiti	Shallow soil	Suelo delgado
Echeri jauamiti	Deep soil	Suelo profundo
Echeri tsuruani	Single-layered soil	Suelo sin capas
Echeri kurhunda	Multi-layered soil	Suelo con capas
Echeri uekandirini	Moist soil	Suelo húmedo
Echeri karishiri	Dry soil	Suelo seco
Echeri charanda	Clayey soil	Suelo arcilloso
Echeri tupuri	Silty or powdery soil	Suelo polvillo
Echeri kutzari	Sandy soil	Suelo arenoso
Echeri charakirhu	Gravelly soil	Suelo gravoso
Echeri zacapendini	Stony soil	Suelo pedregoso
Echeri poksinda	Soil with clods	Suelo con terrones
Echeri cuatapiti	Loose soil	Suelo suelto
Echeri choperi	Hard soil	Suelo duro
Echeri querekua	Sticky soil	Suelo pegajoso o chicloso
Echeri turipiti	Dark or black soil	Suelo obscuro o negro
Echeri spambiti	Yellowish soil	Suelo amarillo
Echeri charapiti	Reddish soil	Suelo colorado
Echeri urapiti	Whitish soil	Suelo blanco
Echeri jorhépiti	Warm soil	Suelo caliente
Echeri tshirápiti	Cold soil	Suelo frío
Echeri tsuruani	Eroded or washed soil	Suelo de arroyada o compuesto
Echeri kurhunda	Alluvial soil	Suelo de derramadero
Echeri ambakiti	Fertile soil	Suelo bueno
Echeri terendani	Decomposed litter	Suelo de pudrición
Echeri ietakata	Mixed soil	Suelo mixto
Echeri tsuruani	Simple soil	Suelo sencillo
Charanda	Clay	Arcilla
Tupuri	Silt (dust)	Polvillo
Kutzari	Sand	Arena
Kutzari sahuapiti	Fine sand	Arena fina
Kutzari tepari	Coarse sand	Arena gruesa
Charaki	Gravel	Grava
Tzacapu	Stone	Piedra
Tzacapu xanamu	Pumice stone	Piedra pómez
Tzacapu uiramu	Hard white stone	Piedra laja
Tzacapu tareri	Weathered stone	Piedra podrida
Siranga	Root	Raíz
Siranga sahuapiti	Fine root	Raíz fina
Siranga tepari	Coarse root	Raíz gruesa



RELIEF TYPE	VEGETATION COVER and LAND USE	MAIN SOIL TYPE
Teronstakua (Crest) Sanish uanangaristi (Steep slope)	Pukuricharhu (Pine forest)	Echeri tupuri terendani (Littered dusty soil)
Terongarikua (Mid-slope)	Taretarhu (Agricultural plots)	Echeri tupuri turipiti (Black dusty soil)
Jukari uanangaristi (Moderate slope)	Uanikua pukuricha ka uirikuicha (Pine-oak forest)	Echeri tupuri turipiti / spambiti (Black yellowish dusty soil)
Juatarhu janikutini nirani (Footslope)	Anbakurhi (Grassland)	Echeri tupuri turipiti (Black dusty soil)
Tpakua (Valley)	Taretarhu (Agricultural plots)	Echeri tupuri spambiti (Yellow dusty soil)
Ketsimani (Lower valley)	Taretarhu (Agricultural plots)	Echeri tupuri turipiti terendani (Black littered dusty soil)
Tpakua (Valley)	Taretarhu (Agricultural plots)	Echeri tupuri spambiti (Yellow dusty soil)
Kerendarhu (Cliff)	Uirikuicha (Oak forest)	Echeri tzacapendini juskua karihiran (Stony soil on cliff)
Tzacapurhu (Stony soil)	Taretarhu (Agricultural plots)	Echeri tupuri zacapendini terendani (Stony dusty soil)
Juata sapichu (Hill)	Uanikua uirikuicha ka pukuricha (Oak-pine forest)	Echeri tupuri terendani (Littered dusty soil)

Figure 1 Purhepecha perception of soil-land distribution patterns.

(3) Land in footslope positions (juatarhu janikutini nirani) is recognized as being heterogeneous because of the strong intermingling of eroded soils and depositional soils. Eroded and washed soils are shallow, yellowish or reddish, dust-clayey, gravelly, hard when dry, sticky when wet, with pumice stones, and drying up fast. Depositional soils are deep, dark, dusty, moist, with good "strength" and thus suitable for agricultural

uses. The association of eroded and depositional soils is called echeri tupuri spambiti-charapiti ka echeri charanda charapiti (Typic Haplustands and Typic Haplustalfs). Locally, there are dark red soils, very hard when dry, very sticky when wet, and nutrient-depleted; they are called echeri charanda charapiti-turipiti (Typic Haplustults). In general, footslope land is considered “cold”.

(4) The valley landscape (tpakua) includes several land types. Soils have formed from alluvial deposits, are deep and multi-layered, and benefit from permanent influx of nutrients coming from the neighboring mountain slopes (echeri itsírhuky or “juice”). In general, valley soils are fertile. In the upper valley stretches, soils are dark or yellowish dark, and dusty. These soils are called echeri tupuri turipiti terendani (Humic Haplustands). In valley bottoms at lower elevation, soils are deep, reddish, clayey and sticky when wet. They are named echeri charanda charapiti (Typic Haplustalfs). In the margin of the valleys, soils are shallow and gravelly. They dry up very fast and, after drying, they become hard and form clods. They are named echeri querekua (Typic Haplustepts). In general, valley soils are considered “warm”.

(5) Soils on lava-flow plateaus (tzacapurhu or jatsikurini) are shallow, dusty or sandy, with a lot of gravel. A surficial horizon of decomposed oak leaves forms under forest cover. Although soils tend to dry up easily, porous pumice stones retain heat and moisture. These soils are called echeri tupuri zacapendini terendani (Lithic Humic Haplustands). They are considered “cold”. Soils on lava cliffs (kerendarhu) are stony, shallow, black or yellowish black, with a surficial horizon of decomposed oak leaves. They are named echeri zacapendini juskua karihiran (Lithic Humic Haplustands).

Land movement and behavior

Farmers recognize, accept and work with the fact that land is not an immutable but a dynamic “subject”. This concept is reflected in the expression: “land moves and behaves” (Figure 1). Land behavior changes throughout the year according to seasonal rhythm, climatic variability, rainfall occurrence, and management practices. Similarly, land movement is according to its position on the landscape. The local discourse on land behavior and movement is similar to the one addressing other biological organisms. Although not explicitly stated, the farmer considers soil as a living organism. Like other living beings, soil-land can be tired, thirsty, hungry, sick or getting old. However, because soil can grow up again, be rejuvenated, recovered or rehabilitated, it is also considered fundamentally different from other living organisms, which are ineluctably condemned to perish.

The lixiviation of substances through the soil, leading to fertility depletion, and the remotion, transfer and deposition of debris at the terrain surface, are perceived as “normal” processes affecting the land as a living being. The strategy adopted by the farmer to deal with these processes is to benefit from them rather than strictly control them or heavily counteract. The word “erosion” does not exist in Purhépecha language, although farmers clearly identify the process of remotion and assess its severity. Soil erosion is recognized as a natural phenomenon, the severity of which might overrun the farmer’s control capability, but is not perceived as a negative phenomenon leading to land degradation. It is considered as a periodical process, which depends on land management but is also an integral part of it. Soil debris eroded upslope benefit agricultural fields downslope through enrichment in mineral nutrients and organic matter. In this sense, farmers establish a difference between temporary and definitive improvement. Fields on backslopes and footslopes can only be temporarily improved, because overlandflow materials (tsuruani) are in transit and land requires a fallow period to fully recover from use. Instead, the constant accumulation of debris (iorhejpiti) on toeslopes and valley bottoms promotes permanent improvement, which allows continuous and intensive land use.

Land resilience and restoration

Farmers apply practices on a regular basis to improve land quality, but they may also implement exceptional measures to rehabilitate or restore more depleted soils. The way of compromising with nature, by accepting upslope erosion and taking advantage of downslope deposition, is coupled with active sloping land management by means of measures such as sediment trapping, bunds, living fences, deviation of intermittent waterways, terrain leveling and intensive manuring. A common practice consists in leaving the maize stalks standing on the field after harvest, as a multiple-effect measure which slows down the remotion of topsoil material, adds organic residues to the soil, and provides fodder to browsing livestock, which in return manures the fields. These management practices, carried out through a variety of small local measures, often imperceptible at landscape level, are commonly implemented on sloping fields of temporary use to diminish fallow length.

Land quality

Land quality reflects a combination of the former three principles, referring to the land potential and constraints that result from the position on the landscape, the intensity and periodicity of erosion and deposition of materials, and the management practices applied. Land quality is assessed on the basis of a set of criteria, including landscape position, micro-climatic conditions, selected soil properties, and soil fertility (soil "strength"). The concept of "cold-warm" is frequently used to refer to variable combinations of these criteria. For instance, cold soils (echeri tshirápiti) are on slopes, while warm soils (echeri jorhépiti) are on valley bottoms. But the same attributes of cold and warm may be used in a completely different manner when referring to texture: silty and sandy soils are considered cold, while clayey soils are considered warm, regardless of their topographic position. Fertile soils, enriched by the deposition of mineral and organic debris, are qualified as warm; instead, eroded soils on slopes are qualified as cold. Practically, the antonyms "warm" and "cold" are used when assessing the requirement of chemical fertilizers, in particular the need of ammonium sulphate, higher in cold soils and lower in warm soils

Integrated Land Management Practices

On the basis of these four management principles, farmers recognize three main land classes, primarily controlled by landscape position and requiring different land care: land on steep slopes, land on valley bottoms, and land in special conditions.

Land on steep slopes

(1) Qualities and limitations:

- Shallow, simple soils, with only a few layers.
- Erodible soils.
- Soils unable to retain moisture, which dry up quickly.
- Stony or gravelly soils.

- Weak soils, which get tired quickly.
- Soils less productive than the average.
- Soils exposed to sediment transit, which allows temporary recuperation during fallow period.
- Some of these soils require more fallow than work.
- North-facing sloping land is prone to frost and therefore risky to cultivate.

(2) Care required:

- Areas with trees on steep topography are preserved to counteract erosion and favor litter accumulation to increase soil organic matter.
- Plowing is perpendicular to slope to control and deviate overland flow for crop moistening.
- After harvest, maize stalks are left standing on the field to counteract wind erosion during the dry season.
- Livestock pastures on crop residues and manures fallow land when browsing.
- Bunds are constructed at the foot of the cultivated fields to retain eroded mineral and organic debris, using stones or planting fruit trees. The latter are particularly recommended because they provide food to birds, badgers and squirrels, and prevent them from feeding on maize, while at the same time protecting crops from wind effect.

Land at valley bottoms

(1) Qualities and limitations:

- Deep soils with several layers.
- Loose soils, always moist and enriched with erosion debris coming downhill.
- “Strong” and “warm” soils.
- Soils usually free of stones and gravel.
- Soils which do not get quickly “tired”.
- Soils which can produce a lot, depending on care intensity.
- Soils exposed to flood, wind, hail and frost.
- Soils prone to pests and diseases.

(2) Care required:

- Crop rotation is practiced to compensate for soil deficiencies.
- Sowing and planting must be timely to prevent crops from being affected by drought or rainstorms.
- Fruit trees are planted around the cultivated fields to control wind, hail and pests.
- Combination of organic and chemical fertilizers is required to compensate for soil fertility depletion.

Land in special positions

Land very site-specific, such as land occurring on rocky ground (lava flows), in piedmont areas, or in homegardens and backyards, receives special care.

(1) Soils on lava flows and in piedmonts:

- Soils are stony, simple or composite, and of variable depth. Their strength varies according to their location and the intensity of sediment influx.
- Litter accumulating under forest cover counteracts soil susceptibility to erosion.
- Soils have variable combinations of properties because of their transitional situation.
- Soils are too cold and require to be sown using a digging stick, but heat and moisture stored in pumice stones provide "strength". Crop adaptability is carefully assessed on individual basis.
- Fields are often surrounded by oak trees providing litter to decompose into soil organic matter.
- This special land is considered a security land, the use of which depends on the household needs. It is not permanently used because it requires a lot of attention.
- Soil production is low but sustained.

(2) Soils in homegardens and backyards:

- These are the most fertile and deepest soils; they are free of stones and have several layers.
- Soils are not ploughed and crops are planted using a hoe.
- Soil fertility is maintained only with organic amendments (oak-leaf litter, ash and manure).
- Soil care is crop-specific and done by women.
- The cropping system includes perennial, biannual and annual species.

Conclusions

The example of San Francisco Pichátaro demonstrates that traditional agriculture does not necessarily lead to land degradation. Farmers clearly understand that land under intensive use is exposed to erosion, structural deterioration and fertility depletion, and are well prepared to identify the causes, assess the severity and apply remedies. Soil erosion is not an issue the farmer deals with when it has become severe enough to make him worried about it. Soil erosion, as well as fertility depletion, is controlled and monitored the year around and year after year to take timely the appropriate corrective measures. Assessment, control and monitoring of land degradation are integral parts of land management to secure sustainable land use. Understanding land degradation and the practical experience to handle it are embodied in the knowledge corpus of local farmers. This indigenous knowledge is:

(1) shared by all members of the community, with minor variations according to age, gender and level of experience;

(2) transferred from generation to generation via practical demonstrations, informal conversations and participatory meetings;

(3) explained symbolically and/or logically by recognizing cause-effect relationships;

(4) conceptualized by formalizing practical experience into knowledge rules.

Farmers' knowledge body (Corpus) on land degradation and sustainable land management is derived from the symbolic meaning attached to land (Kosmos) and a longstanding farming experience (Praxis) (Barrera-Bassols and Zinck, 2002).

Altogether, it represents the social theory of land management the community has developed via centuries of co-evolution. This collective knowledge is increasingly exposed to fragmentation, as the community undergoes structural changes and loses its social cohesion under the impact of externalities such as off-farm activities, out-migrations and governmental intervention.

References

Barrera-Bassols, N. 2002. Peoples' soil knowledge: global, regional and local. Ph.D. Thesis, Gent University / ITC Enschede. Gent, Belgium. 600 p (in preparation).

Barrera-Bassols, N. and J.A. Zinck. 2002. Ethnopedology: a worldwide view on the soil knowledge of local people. Geoderma (accepted).

Bocco, G. and J. Pulido. 2001. Conocimiento tradicional del paisaje y manejo de laderas, pp. 84-95. *In* J.L. Palacio-Prieto and M.A. Sanchez (eds.). Una Perspectiva Geomorfológica. Geography for the Third Millenium. Instituto de Geografía, UNAM, Mexico.

Katz, E. 1997. Ritos, representaciones y meteorología en la "Tierra de la Lluvia" (Mixteca, México), pp. 99-134. *In* M. Goloubinoff, E. Katz and A. Lammel (eds.). Antropología del clima en el mundo Hispanoamericano. Tomo II, Colección Biblioteca Abya-Yala No. 50. Ediciones Abya-Yala, Quito, Ecuador.

Motte-Florac, E. 1997. Santos, humores y tiempo: el clima y la salud entre los Purhé pechas de la Sierra Tarasca (Michoacán, México), pp. 179-210. *In* M. Goloubinoff, E. Katz and A. Lammel (eds.). Antropología del clima en el mundo Hispanoamericano. Tomo II, Colección Biblioteca Abya-Yala No. 50. Ediciones Abya-Yala, Quito, Ecuador.

Zonneveld, I.S. 1995. An introduction to landscape ecology as a base for land evaluation, land management and conservation. *In* Land Ecology. SPB Academic Publishing, Amsterdam. 199 p.