MATRIX BASED FOREST MANAGEMENT

An emerging paradigm for biodiversity conservation

The policy makers and the conservation scientists must realize that conservation of biological diversity is not primarily a set-aside issue that can be dealt with by reserving or modifying management on huge landscape; rather, it is a pervasive issue that must be considered on every acre of land that they manage.

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Forest patches must be taken care of

A land area of more than 0.5 ha, with a canopy cover of more than 10 percent and trees able to reach a minimum height of 2-5 metres at maturity in situ can be called a forest. It includes areas with rattans, bamboos and palms provided that height and canopy cover criteria are met. Forest also includes forest roads, firebreaks, meadows, other small open areas, windbreaks, shelterbelts, corridors of trees, national parks, nature reserves and other protected areas which have specific scientific, historical, cultural or spiritual interest. According to Lindemayer & Franklin (2002), matrix comprises landscape areas that are not designated primarily for conservation of natural ecosystems, ecological processes, and biodiversity regardless of their current condition (natural or developed).

Massive deforestation has led to striking fragmentation of natural forests throughout the world. Fragmented forests are composed of small patches. Usually human-fragmented forests maintain some degree of terrestrial connectivity via the matrix of modified habitats surrounding fragments. Biodiversity is impacted by the sizes of forest patches, remaining continuous forest, and the intervening matrix. The matrix is important in the evolution of fragment dynamics for several reasons. The forest matrix often acts as a corridor for the movements of species across the landscape. It exerts a strong influence on remnant community dynamics. Species associated with the matrix alters the species composition of some taxonomic groups. Matrix influences the edge effects of forest fragments. The matrix surrounding matrix has pervasive effects on vertebrate communities in forest fragments. A substantial number of nominally primary-forest species are capable of using matrix habitats, at least when large forest tracts which provide potential sources of immigrants are nearby. Some primary-forest species use matrix habitats for movement and/or reproduction in the tropical forests. The vulnerability of species in fragments is related to their ability to use matrix. A disappeared species from the fragments may be colonized in the matrix.

Structural diversity of both habitat remnants and surrounding matrix is an important factor for explaining plant population dynamics and ecosystem functions in human-impacted landscapes. Forest fragmentation severely threatens the maintenance of biodiversity and the functioning of ecosystem worldwide. Small population size due to habitat loss, collapsed metapopulation by habitat isolation, and decreased individual potentiality due to edge effects are pivotal processes that frequently lead to the extinction of species in fragmented landscapes. These adverse effects are mainly reported in landscapes where remaining habitat fragments are embedded in a highly contrasting, inhospitable matrix of degraded habitat.

In the tropics and subtropics most of the natural forests are characterized by a continuum mosaic of patches with different degrees of degradation and structural disparity. Matrix has a greater influence on biodiversity patterns in landscape mosaics and on plant-animal relationship.

Forest fragmentation disrupts mutualisms due to habitat loss or increased isolation, and increased antagonisms due to edge effects. The surrounding matrix of the remnant habitats support part of the populations of seed dispersers, serve as temporary habitats, and even favour their individual movements when moving across the whole landscape. The matrix habitats influence ecological processes such as plant-animal interactions within remnant habitat patches in fragmented landscapes. The matrix offers food resources and even breeding areas to frugivores, leading them to tolerate, exploit food resources, and even increase in abundance in matrix habitats.

The presence of scattered trees enriches the structure of pasture matrix. Scattered trees not only provide fleshy-fruited resources for avian frugivores, but resting sites when flying through the landscape. As a result, landscape connectivity is enhanced through seed dispersion. Scattered trees act as bridge between the patches. The matrix habitats lead frugivorous birds to perceive the landscape as a continuum rather than as discrete habitat patches. Seeds within unconnected patches suffer stronger predation than those located within connected patches. Recruitment rates are lower in unconnected patches, thus collapsing regeneration.

The biodiversity conservation has to involve maintenance of habitat at multiple spatial scales, from the scale of centimeters to that of thousands of hectares. For example, critical habitat for some species may be the provision of an individual structure, such as a standing dead tree or a log on the forest floor, in an otherwise human-modified environment. For other species it may be the provision of a large natural reserve, with a diversity of habitat conditions. Resource management practices that maintain or improve the suitability of the matrix are fundamental to the conservation of biodiversity. In fact, approaches to matrix management have major implications for fundamental tenets of conservation biology as reserve design, metapopulation processes, extinction proneness, and connectivity and species persistence in human-modified landscapes.

The future of the vast majority of the earth's species will depend on how the matrix is managed -- including not only the human-perceived habitat patches, but also the extensive areas that surround them. It is highly important to give major attention to the matrix if programmes to conserve the world's biological diversity are to succeed. This includes facilitating the multiple roles of the matrix in management programmes, including provision of habitat and facilitation of movement. Improving matrix quality may lead to higher conservation returns than manipulating the size and configuration of remnant patches for many of the species that persist in the aftermath of habitat destruction.

The policy makers and the conservation scientists must realize that conservation of biological diversity is not primarily a set-aside issue that can be dealt with by reserving or modifying management on huge landscape; rather, it is a pervasive issue that must be considered on every acre of land that they manage. For the matrix management we should consider the following points: 1) the importance of the matrix in key areas of ecology such as metapopulation dynamics, habitat fragmentation, and landscape connectivity; 2) general principles for matrix management; 3) using natural disturbance regimes to guide human disturbance; 4) landscape-level and stand-level elements of matrix management; 5) the role of adaptive management and monitoring; 6) social dimensions and tensions in implementing matrix-based forest management; and 7) the relationship among patch occupancy, patch area and isolation.

We need effective models of our forest management, based on locally appropriate paradigms and application, in which the concept of sustainability is set in the broader context of managing production forests. Albeit a network of protected areas is necessary for conserving natural forests and their biodiversity. High forest fragmentations will be vulnerable for the biodiversity to sustain.

Woodlot Plantation forests, therefore, need to be managed for more than just timber production -- also for objectives such as supporting local livelihoods, biodiversity conservation, and environmental services, including carbon capture and storage.

For conserving biodiversity, this may require thinking in terms of managing the landscape as continuum of patches, corridors, and matrices.

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Sustainable urban planning

Curitiba instance

Curitiba's buses carry 50 times more passengers than they did 20 years ago, but people spend only about 10 percent of their yearly income on transport. As a result, despite the second highest per capita car ownership rate in Brazil (one car for every three people), Curitiba's gasoline use per capita is 30 percent below that of eight comparable Brazilian cities. Other results include negligible emissions levels, little congestion, and an extremely pleasant living environment

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Sustainable Curitiba

CURITIBA has a master planned transportation system, which includes lanes on major streets devoted to a bus rapid transit system. The buses are long, split into three sections (bi-articulated), and stop at designated elevated tubes, complete with disabled access. The system, used by 85% of Curitiba's population, is the source of inspiration for the TransMilenio in Bogotá, Colombia, as well as the Orange Line of Los Angeles, California, and for a future transportation system in Panama City, Panama.

The city has also paid careful attention to preserving and caring for its green areas, boasting 54 m² of green space per inhabitant.The city of Curitiba provides the world with a model in how to integrate sustainable transport considerations into business development, road infrastructure development, and local community development.

Curitiba first outlined its Master Plan in 1965, with the main goals of limiting central area growth and encouraging commercial and service sector growth along two structural north-south transport arteries, radiating out from the city centre. The Master Plan also aimed to provide economic support for urban development through the establishment of industrial zones and to encourage local community self-sufficiency by providing all city districts with adequate education, health care, recreation, and park areas.

The Master Plan established the guiding principle that mobility and land use cannot be disassociated with each other if the city's future design is to succeed. In order to fulfil the goals of the Master Plan in providing access for all citizens, the main transport arteries were modified over time to give public transport the highest priority.

Although Curitiba is known internationally as a sustainable, ecological city, it calls itself "the city of all of us." In almost any area of Curitiba's urban planning over the years, it is possible to see how consideration has been given to people in the big picture--and also to see the associated, system-wide sustainability benefits of integrated planning.

What is most unique about the city's strategy: is that it maximizes the efficiency and productivity of transportation, land-use planning and housing development by integrating them so they support one another to improve the quality of life in the city.

Integration of traffic management, transportation and land-use planning in the 1970s allowed the city to meet strategic objectives which sought to minimise downtown traffic, encourage social interaction by providing more leisure areas and pedestrian zones in the centre of the city, and encourage the use of public transport and cycling in order to achieve an environmentally healthy city.

The urban transportation system is one of Curitiba's best-known planning successes, a model for cities around world that want to implement eco-efficient transportation networks that are well-integrated with urban form and produce environmental benefits.

The city pioneered the idea of an all-bus transit network with special bus-only avenues created along well-defined structural axes that were also used to channel the city's growth. The transit system is rapid and cheap, and is currently being integrated with the metropolitan region.

Each of the five arteries contains one two-way lane devoted exclusively to express buses. This inner lane is flanked on either side by i) a local access lane for cars and ii) a high-capacity one-way route for use by both cars and buses. Separating traffic types and establishing exclusive bus lanes on the city's predominant arteries helped to mold two defining characteristics of the city's transport system: a safe, reliable, and efficient bus service operating without the hazards and delays inherent to mixed-traffic bus service; and densification of development along the bus routes.

About 1,100 buses make 12,500 trips per day, serving 1.3 million passengers. Five different types of buses operate in Curitiba:

- Express buses operate exclusively on the arteries' dedicated bus ways.
- "Rapid" buses operate on both the arteries and other main streets throughout the city, and their routes are changed to respond to demand. These buses stop at tube-shaped stations designed for protection from the weather and for quick bus entry and exit.
- "Bi-articulated" bus, introduced in December, 1992, is a form of rapid bus operating on the outside high-capacity lanes. Bi-articulated buses - the largest in the world - are actually three buses attached by two articulations, and are capable of carrying 270 passengers.
- "Inter-district" buses bring passengers between the city's sectors lying between the arteries, and thus provide a crucial link between the routes of the express and bi-articulated buses.
- Finally, "feeder" buses mix with traffic on all other city streets and bring passengers to transfer stations called "District Terminals," around which local urban development and commercial activity have flourished.

Curitiba's buses are privately-owned by ten companies, managed by a quasi-public company. With this public-private collaboration, public sector concerns (e.g. safety, accessibility, and efficiency) are combined private sector goals (e.g. low maintenance and operating costs). The bus companies receive no subsidies; instead all mass transit money collected goes to a fund and companies are paid on a distance traveled basis.

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Its efficiency encourages people to leave their cars at home. Curitiba has one of highest rates of car ownership in Brazil, and high population growth. Yet auto traffic has dropped substantially; Curitiba has the highest public rider ship of any Brazilian city (about 2.14 million passengers a day), and it registers the country's lowest rates of ambient pollution and per capita gas consumption.

In addition, an inexpensive "social fare" promotes equality, benefiting poorer residents settled on the city's periphery. A standard fare is charged for all trips, meaning shorter rides subsidize longer ones. One fare can take a passenger 70 kilometers.

Curitiba is referred to as the ecological capital of Brazil, with a network of 28 parks and wooded areas. In 1970, there was less than 1 square meter of green space per person; now there are 52 square meters for each person. Residents planted 1.5 million trees along city streets. Builders get tax breaks if their projects include green space. Flood waters diverted into new lakes in parks solved the problem of dangerous flooding, while also protecting valley floors and riverbanks, acting as a barrier to illegal occupation, and providing aesthetic and recreational value to the thousands of people who use city parks.

The "green exchange" employment program focuses on social inclusion, benefiting both those in need and the environment. Low-income families living in shantytowns unreachable by truck bring their trash bags to neighbourhood centers, where they exchange them for bus tickets and food. This means less city litter and less disease, less garbage dumped in sensitive areas such as rivers and a better life for the undernourished poor. There's also a programme for children where they can exchange recyclable garbage for school supplies, chocolate, toys and tickets for shows.

Under the "garbage that's not garbage" programme, 70% of the city's trash is recycled by its residents. Once a week, a truck collects paper, cardboard, metal, plastic and glass that have been sorted in the city's homes. The city's paper recycling alone saves the equivalent of 1,200 trees a day. As well as the environmental benefits, money raised from selling materials goes into social programmes.

The result of the strategy--which put people at the centre and emphasized integrated planning--is that the city has become a showcase of ecological and humane urbanism, with ongoing improvements over the past 38 years to social, economic and environmental conditions for its residents.

Curitiba has become the most sustainable of cities, in the process proving that applying a city-strategy with strong values and a focus on integrated systems can harness the actions of planning departments to meet common strategic objectives.

The writer is a development activist.