

Ecosystem approaches and health in Latin America

Enfoques ecossistêmicos e saúde: vertentes e aplicações na América Latina

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Abstract

Important environmental changes that have become increasingly pronounced in the last two centuries and that are seriously affecting human health require the development of integrated and participatory scientific approaches that can result in proposals for institutional and public policy changes. The purpose of this article is to offer some elements that can contribute to a line of reflection based on studies with ecosystem approaches in the Latin America context. The authors begin with a brief description of current scientific literature in public health that links ecosystems and human health in Latin America; next, they describe and compare the two prevailing trends that form the basis for the theoretical and methodological debates on ecosystem approaches; they also review the empirical research in Latin America or concerning Latin American countries in which an ecosystem approach has been adopted. The results point to limited scientific output on the interface between ecosystems and human health; aspects involving public participation and implementation of institutional changes and public policies are still in a rather incipient stage.

Ecosystem; Environmental Health; Public Health

Introduction

The scale, magnitude, and uncertainties permeating the current environmental crisis reveal how human activities have produced drastic environmental changes at the local and global levels, resulting in numerous serious health problems. Due to their very complexity, these problems require a search for alternative approaches that combine socioeconomic and biophysical aspects for better understanding and solutions.

The need to develop these alternative approaches has intensified at the transition from the 20th to the 21st century. The report of the World Resources Institute (WRI) ¹ for 2000-2001 illustrates this process, pointing to the need to adopt an ecosystem approach premised on the capacity to contribute to: (1) the combination of diverse types of information that allows a careful weighing of the trade offs among various ecosystem goods and services and among environmental, political, social, and economic goals; (2) developing wiser policies and more effective institutions to improve ecosystem management; and (3) public participation (particularly that of local communities) in ecosystem management.

Another major initiative is the *Millennium Ecosystem Assessment* program ², conducted by the United Nations, launched in 2001 and with results published in 2005. The program was designed to respond to needs for information on

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how ecosystem changes can affect human well-being, with answers that can be obtained at different levels (local, national, and global) to improve ecosystems management and thus help improve human well-being.

Ecosystems changes in these systems can have present and future consequences, resulting in socio-ecological problems that must be included on the global scientific and political agendas. The approaches developed to understand and solve them should allow dealing with the dual relationship between scientific knowledge and process decision-making.

The current article aims to contribute to the development of these approaches in the Latin American context. We begin by briefly describing the current scientific literature in the public health field concerning ecosystems and human health in Latin America. Next we describe and compare the two approaches at the base of the theoretical and methodological debate on ecosystem and health. Finally, we analyze the empirical studies with ecosystem approaches by Latin American researchers or on Latin American countries based on the two approaches: (1) situating their studies in relation to the two approaches and (2) identifying the presence and limits of applying the three premises identified in the WRI report ¹.

Ecosystems and ecosystem approaches in Latin American public health journals

In the early 21st century in Latin America, and particularly in Brazil, discussions and studies have emerged in the public health field based on these approaches. In 2001, the journal *Cadernos de Saúde Pública/Reports in Public Health* published one single article ³ and a special issue devoted to the theme ⁴. These articles as a whole dealt with such issues as application of these approaches for an understanding of tropical diseases; integrated management of diseases and natural resources; community mobilization and participation; and surveillance and monitoring strategies for environmental and health problems. In 2002, other types of publications (theoretical and conceptual) like a book chapter on health and sustainable environment ⁵ and a document ⁶ published by the Regional Office for Latin America and the Caribbean (in Uruguay) of the International Development Research Centre (Canada) have emerged as important contributions.

A survey of Latin American public health journals available on SciELO (<http://www.scielo.org>) up to 2004, using “*ecosistema*” and

“ecosystem” as descriptors, identified 23 articles. Of these, four adopt a vector ecology approach ^{7,8,9,10}; two study the interface between vector ecology and the ecosystem as a modified place ^{11,12}; eight deal with the ecosystem as a place that has been modified and become disease-prone ^{13,14,15}, in which viruses are present ^{16,17}, where diseases occur ^{18,19}, and as the place in which intervention should occur ²⁰; and nine adopt ecosystem approaches which in some way include the premises laid out in the WRI report ¹. Only one of the nine studies was published by a Brazilian researcher ³. The others are distributed geographically as follows: four by Latin America researchers, namely from Peru ²¹, Colombia ^{22,23}, Paraguay ²⁴, and Argentina ²⁵; two by Canadian researchers ^{26,27}; one by a Swedish researcher ²⁸; and one involving cooperation between researchers from Kenya, Sweden, and Italy ²⁹.

Only recently has the Latin American public health literature incorporated the words “*ecosistema*” or “ecosystem” (the oldest articles only date back to 2000). This recent incorporation has meant that in most of the articles, the ecosystem is not treated from a systemic approach, but as the place for the vector (vector ecology), virus, disease, or intervention.

The two ecosystem approaches

We identified two current approaches at the base of studies. The first focuses on the identification and measurement of signs and symptoms of changes in ecosystems and their current or future potential to affect human health, so as to back decision-making and management with scientific information ^{30,31,32}. The second values the development of contextualized and participatory approaches for understanding and searching for strategies to manage ecosystem changes in given places (villages, hamlets, and small towns, for example) and their impacts on the health of local communities ^{33,34,35}.

Ecosystem health approach

The ecosystem health approach aims to be a science that integrates the natural sciences (biophysical dimension), social sciences (socioeconomic dimension), and health sciences (human health sciences). Using the metaphor of the ecosystem as a patient, it proposes to: (1) diagnose ecosystem dysfunctions by monitoring signs and indicators, distinguishing between “healthy” (desirable) ecosystems and “unhealthy” (undesirable) ones; (2) offer ecosystem management

options that reduce the costs of post-damage interventions, losses of economic opportunities, risks to human health, and social disruption due to environmental degradation^{36,37}.

As an integrating science, the ecosystem health approach seeks to transcend the limits of the dominant approaches, both economic (centered on market prices that reflect the current scarcity of natural resources and failing to consider the consequences for future generations), ecological (a tendency to set society and economic activities aside, treating them as “external” forces), and engineering (the search for targeted solutions based on command and control strategies)^{36,37}.

The approach considers four dimensions and eight attributes. The first dimension is biophysical, assessing the ecosystems’ structures and functions (nutrient cycles, energy flows, and diversity of species and habitats, among others). The socioeconomic dimension emphasizes differences in the ecosystems’ productive capacity and the valorization of ecosystems’ services by populations and their repercussions on economic policies. The human health dimension seeks to establish a causal nexus between the imbalance in the ecosystems’ health status and diseases and human health risk. The spatial-temporal dimension considers the different responses to the multiple forms of environmental stress that produce complex changes with a cumulative and/or synergistic effect that can threaten the very viability of the ecosystems at the local and/or global level^{36,37}.

As for attributes, the approach suggests eight criteria or indicators for ecosystem health that are applicable to the integration of the above-mentioned dimensions. The first three criteria (vigor, resilience, and organization) are considered prime components of ecosystem health (structure and functions) and are characterized by their predominantly biological origin. The other criteria represent the management, planning, and sustainability capacity of the mitigation and compensation measures adopted by society for situations involving environmental harm^{36,37}. Table 1 describes these eight attributes.

Ecosystem approach to health

The point of departure for the ecosystem approach to health is that disease and health manifestations occur in complex socio-ecological contexts, characterizing ecosystems as self-organizing holarchic open systems (SOHO). The objective is to identify connections between human health and activities or events that disturb the ecosystem’s status and function^{27,33,34}.

Under the theoretical framework developed by the ecosystem approach to health, complexity and uncertainty are inherent to socio-ecological systems, which involve a set of hierarchical groupings on multiple scales (spatial and temporal) that tend to organize in social and ecological feedback cycles, which in turn can contribute complexly to establishing critical instability points that sometimes result in the emergence of new structures and organizational forms. These alterations, characterized by different levels of uncertainties, can result in abrupt changes in the socio-ecological systems, ranging from minor alterations to environmental tragedies involving the emergence of pests or epidemics^{27,33,34}.

The methodology is characterized by: (1) targeting local and regional ecosystem and health problems and (2) pluralism as the basic research strategy, incorporating multiple methods and forms of participation by local social actors. The approach is oriented by valorization of social collaborative learning processes involving specialists and local social actors, without separating problem understanding (research and analysis) from proposals for management and public policy strategies^{33,34}.

The perspective is that pluralism, participation, and social and collaborative learning processes can lead to a type of adaptive management which emerges as an alternative, as well as complementing traditional anticipatory management. In adaptive management, the differences between how the future is anticipated and how it actually plays out are viewed as learning opportunities. The adaptive focus of the ecosystem approach to health presumes that decisions concerning environmental issues involve the mapping and construction of scenarios for how the territories or social and ecological systems should co-evolve as a self-organized entity. This path should also allow identifying the social stakeholders and interests, life histories, concerns, and future perspectives^{34,35}.

Like the ecosystem health approach, the ecosystem approach to health also considers attributes or indicators that allow identifying whether an ecosystem is healthy or not, but its methodology focuses on the process and considers two fundamental aspects: (1) the frontiers of an ecosystem and/or environmental problem are established through negotiation between the various social actors and (2) the roles and responsibilities of the different social actors are defined at each step. These two aspects require that those adopting the approach set clear rules for negotiation, ways of involving different actors with opposing interests and resolving social at appropriate moments, and strategies to maintain the actors’ par-

Table 1

Attributes of the ecosystem approach to health.

Name of attribute	Definition
Vigor	Refers to energy or activity in the context of an ecosystem. Energy refers to throughput of energy that can be measure in terms of nutrient cycling and productivity. Although the higher throughput is associated with healthier system, excessive throughput can cause major problems
Resilience	Refers to a system's capacity to deal with stress and return to the previous state after the stress decreases. This capacity is referred to as "counteractive capacity" and is measured by a system's capacity to recover after a disturbance
Organization	Refers to the complexity and interrelationship between different biotic and abiotic elements in each ecosystem. Ecosystems under stress generally display reduced species richness, few symbiotic relations, and more opportunistic species among their elements
Maintenance of ecosystem services	This attribute has emerged as a key criteria for evaluating ecosystem health and refers to the functions that benefit human communities, like detoxification of chemical substances, water purification, production of interrelations between species, and reduction of soil erosion
Management options	Healthy ecosystems offer greater diversity of potential uses, such as harvests of renewable resources, recreation, and water supply for human consumption. Meanwhile, ecosystems under stress do not provide many options for use or fail to maintain/support such options for long periods of time
Reduced subsidies	Healthy ecosystems do not require an increase in subsidies to maintain their productivity. Examples of subsidies in agriculture include such additional inputs as use of pesticides, herbicides, and fossil fuels. Subsidies can also occur in the form of economic incentives that end up encouraging the over-exploitation of natural resources, without requiring that the resulting production internalize the environmental and health costs. These costs generally tend to be transferred to society as a whole and not to the projects that degrade the environment
Damage to neighboring systems	Some ecosystems may prosper at the expense of others. An example is when residues or contaminants in a given region are transported beyond its borders, leading to damage in other ecosystems
Effects on human health	Health human can serve as a synoptic measure of the ecosystem's health. Healthy ecosystems are characterized by their capacity to sustain health human populations

Source: Rapport 37.

ticipation throughout the process, reaching the formulation of management and public policy strategies^{34,35}.

Ecosystem approaches and public health in Latin America

To analyze this item, we contend that the premises in the report *People and Ecosystem: The Fraying Web of Life*¹ are all necessary in order to scientifically recognize the "systems" in ecosystems holistically rather than sectorially, contributing directly to decision-making. These premises have also appeared in recent books published on the theme in Canada^{34,35}, whose focus has influenced the research produced in Latin America^{21,22,23,24,25}. Thus, it is no coincidence that the five selected articles have their research results published in the special issue of *Cadernos de Saúde Pública/Reports in Public Health* entitled *An Eco-*

logical Approach to Human Health: Emerging and Communicable Diseases, which resulted from an event organized and financed by the Canadian International Development Research Centre (IDRC) at the Brazilian National School of Public Health in November 1999. After demarcating the field of analysis, we seek to situate these articles, which simultaneously reflect on a moment of transition and more systematic introduction of the ecosystem approach to health in Latin America, in relation to their proximity to the dominant watersheds, and to analyze the presence and limits of applying the three premises identified in the WRI report¹.

Combination of diverse information

According to this first premise, an ecosystem approach necessarily involves a combination of diverse information that allows demonstrating the interfaces between goods and services from

various ecosystems, which should be balanced with the environmental, political, social, and economic goals¹. Of the five articles selected for a more detailed analysis, the study by Sosa-Estani et al.²⁵ on hantavirus pulmonary syndrome in Argentina was the only one with combined information on different spatial scales and diverse environmental/ecological variables for the problem at issue. The authors worked with a set of information that is relatively common to studies in the health field (serology; death records for infected individuals; identification of viral genotypes and phenotypes; identification of the rodent species involved). From the perspective of the ecosystem health approach, of the eight attributes that should be considered to assess an ecosystem's health, only the eighth (the effects on human health) was examined through the set of information that was collected. From the perspective of the ecosystem approach to health, the problem's analysis only involved a brief description of the socio-ecological changes in the three regions, but without involving the local communities in this description.

The other four articles^{21,22,23,24} involve assembling pictures that allowed combining a larger set of information divided into two major groups, systematized in Tables 2, 3, 4, and 5. The first set dealt with spatial scales, collecting information at the individual/family/household/residential (Table 2), neighborhood/village/community (Table 3), landscape/municipal (Table 4), and regional/national/global levels (Table 5). At each level, the second set, shown in Tables 2, 3, 4, and 5, dealt with the different dimensions, combining information grouped at the environmental/ecological levels, related to the ecosystem, economic, social, cultural diseases dimensions, and those related to the impacts of the interventions in the ecosystem context.

Both the ecosystem health approach and the ecosystem approach to health deal with the scales analyzed in the articles. However, the ecosystem approach to health prioritizes the local scales (individual/family/household/residential and neighborhood/village/community), although it refers to the others. In the selected studies, there are clear influences by the ecosystem approach to health, due partially to the influence of the International Development Research Centre through funding and events. However, as observed in the *Millennium Ecosystem Assessment*², a complete evaluation of the interaction between humans and ecosystems requires a multi-scale approach so as to allow the analysis of exogenous forces on a location or region to permit assessing the differential impact of changes in ecosystems on human well-being and health and point to different

and combined answers on the different scales. Thus, the fact that the target studies focused on the local scale still proved to limit the search for solutions to the problems.

In these four articles, of the eight attributes considered in the ecosystem health approach, only the effects on human health were effectively considered, and the point of departure for most of the studies was a specific disease (Chagas disease, malaria, leishmaniasis). Although referenced on the ecosystem health approach, the attributes considered primary components of ecosystem health (vigor, resilience, and organization) and others such as management options, subsidies, and damage to neighboring systems were not discussed in any of these articles. The only attribute considered (and even then only in limited fashion) was the maintenance of ecosystem services, which has emerged as a key criterion for evaluating ecosystem health².

As an attribute, ecosystems services refer to the functions that benefit human communities and that programs like the *Millennium Ecosystem Assessment* have viewed as key element for considering aspects pertaining to human health and well-being. According to the *Millennium Ecosystem Assessment*, ecosystems services include: (1) provisioning (food, fresh water, fuel, fibers, biochemical compounds, genetic resources); (2) regulation (climate regulation, disease regulation, flood regulation, detoxification); (3) supporting (services necessary for production of other ecosystem services as soil formation, nutrient cycling primary production); (4) cultural services (non-material benefits obtained from ecosystems, such as leisure and tourism, spiritual, religious, aesthetic, and educational values, cultural heritage, and feeling of belonging to a place).

In relation to provisioning services and the environmental/ecological variables, the only reference we found was in the article by Murray & Sánchez-Choy²¹, focused on the local scales (Tables 2 and 3). The information discussed by these authors was quite general and dealt with the presence of (and access to) natural resources for agriculture, fishing, hunting, gathering, and water consumption. This same article also includes some information on supporting services, focused on the ecosystem's productivity as measured by soil fertility. For regulation services, the articles by Carrasquilla²² and Rojas²³ discuss the environmental/ecological dimensions (Tables 2 and 3) at the local levels, with general information on the alteration in the landscape due to the forms of its use and occupation as a process that disturbs the relationship between humans and the ecosystem, facilitating disease through the intensification of contact with vec-

Table 2

Aggregation: individual/family/household/residential – dimensions/scales and variables present in a study adopting ecosystem approaches.

Dimension/Scales of Integration	Scale of integration
	Individual/Family/Household/Residential
Environmental, ecological, and/or ecosystem	Hygiene practices associated with environmental health ²¹ Access to quality water for human consumption ²¹ Vector-favorable household microclimatic conditions ²⁴ Construction materials ^{23,24} Forms and places in landscape occupation (whether near the forest or periphery) ^{22,23} Location and type of building materials (closer to the forest and more isolated from the village) ²³
Economic	Socioeconomic status and food expenses ²¹ Income by source ²¹ Productivity in the economic activity ²¹ Health education as an element for reducing care for malaria cases ²² Availability of financial resources limiting the use of health services and preventive measures ²² Fish tanks as sources of both family income and potential vector foci ²² Impact of morbidity on the disease influencing productivity ²⁴ Subsistence economy ²⁴ Land tenure, family farming, and family income ²⁴
Social	Access to foodstuffs with quality diet ²¹ Family-level decisions (mother) on use of preventive measures or health services ²² Women making decisions on the family's health and home improvements ²² Morbidity and deterioration of living conditions ²⁴ Schooling ²⁴ Social stigma of persons with diseases ²⁴ Jobs for housing improvements ²⁴ Community participation in control and surveillance strategies (including schools) ²⁴
Cultural	Knowledge, beliefs, and practices leading to actions favoring or preventing disease ²² Practices allowing greater exposure to vector in the household or peri-domicile ²² Interruption of work activities to provide care for sick individuals ²² Perception of the disease ²⁴ Incorporation of rural culture in the urban environment ²⁴ Use of housing ²⁴ Home ownership ²⁴
Diseases in the ecosystem context (socio-environmental system)	Sustainable conditions for vector and species domiciliation ²⁴ Family growth, facilitating vector feeding ²⁴ Domestic animals incorporated into the household, serving as feeding sources for synanthropic animals ²⁴ Peri-domiciliary characteristics ²⁴ Location of dwellings (outskirts of village or close to forest) ²³ Type of local materials used in homebuilding, increasing odds of exposure to vector ²³
Impacts of interventions related to the ecosystem context	Elimination of vector's microhabitat from the household by eliminating cracks through home improvement ²⁴ Vector elimination using chemical products ²⁴ Replacement of building materials and housing improvements in order to decrease vector exposure ²³ Resettlement of scattered families ²³

tors. Also in relation to regulation services, climatic aspects (rainfall, humidity, temperature, global warming, El Niño, La Niña) appear in the articles by Carrasquilla²², Rojas²³, and Rojas-de-Arias²⁴, and as *environmental/ecological* dimensions, but situated on the regional or global scale (Table 5).

The dimensions that the authors referred to as *ecosystem-related* focused on ecosystem regula-

tion services and dealt with climatic aspects^{23,24}, ranging from the residential level (as a function of the building materials and their geographic location near forests) to the regional and global levels (as a function of alteration in the landscape and global climate changes). At the residential level (Table 2), the attempt was to indicate how such factors favor the presence and increase in the vector population at the regional and glob-

Table 3

Aggregation: neighborhood/village/community – dimensions/scales and variables present in a study adopting ecosystem approaches.

Dimension	Scales of integration Neighborhood/Village/Community
Environmental, ecological, and/or ecosystem	Number of houses favoring or preventing the problem ²² Location of houses favoring or preventing contact with vectors ²² Homebuilding rate in recently occupied areas ²² Forms and distribution of landscape occupation ²² Vector-favorable organization of peri-domiciliary space ²⁴ Community's degree of dependence on the ecosystem ²⁴ Macroeconomic projects ²⁴ Residential grouping ²³ Level of community organization ²³ Number of inhabitants ²³ Disease prevalence ²³ Geographic location ²³ Time since village was settled ²³ Level of grouping (nuclear versus scattered villages) points to better or worse community participation and lower disease prevalence ²³
Economic	Access to foods given their prices ²¹ Increase in the number of fish tanks as sources of family income ²² Groups for production and distribution of mosquito nets to poorest families ²² Forms of organization for marketing the community's produce ²⁴ Improvements in facilities (railroads) for marketing the community's produce ²⁴
Social	Social practices (games, conversation) at times of greatest mosquito attack ²² Access to education ²¹ Access to health services ²¹ Community organization ²¹ Community resources and installations ²¹ Community history ²¹ Prioritization of municipalities in control and education related to the disease ²⁴ Formation of farmers' cooperatives ²⁴
Cultural	Community participation through groups to eliminate mosquito attack sites ²² Lack of community organizations ²⁴ Lack of economic culture ²⁴
Diseases in the ecosystem context (socio-environmental system)	Dispersion of dwellings forces residents to cross the forest more often for visits or participation in community activities ²³ Domiciliary and peri-domiciliary vector species, woodpiles, synanthropic reservoirs ²⁴ Dispersion of dwellings ²⁴ Peri-domiciliary characteristics ²⁴
Impacts of interventions related to the ecosystem context	Resettlement of scattered families and promotion of nuclear villages ²³ Vector elimination through mass interventions involving housing improvements and use of chemical products ²⁴

al levels (Table 5) and how changes in regional climate patterns affected agricultural practices and individual behavior as a function of global climate changes, altering rainfall and flood patterns, for example.

The *environmental/ecological* and *ecosystem-related* dimensions comprise a set related to ecosystem changes. A second set of dimensions, discussed next, relates to economic, social, and cultural aspects.

Economic dimensions ^{22,23,24} can be classified in three major groups, related to: (1) the negative impact of morbidity and mortality resulting from disease (Tables 2 and 3); (2) the positive impact of intervention through reduction of morbidity and mortality, highlighting the need for the government to take responsibility for these expenditures (Tables 2 and 3); and (3) organization of the local economy (land tenure, productivity, yields, financing, marketing of crops, corruption, un-

Table 4

Aggregation: Municipality/landscape – dimensions/scales and variables present in studies adopting ecosystem approaches.

Dimension	Scales of integration Municipal/Landscape
Environmental, ecological, and/or ecosystem	Ecosystem productivity (soil fertility) ²¹ Ecological diversity ²¹ Presence of natural resources ²¹ Use of natural resources (agriculture, fishing, hunting, gathering, etc.) ²¹ Economic activities ²² Forms of work and their relationship to the landscape ²²
Economic	Municipal government assumes costs of continuing the program ²² Increase in unemployment rate ²² Decrease in town's economic capacity due to public debt, corruption, and low income level ²² Contribution by municipal government to control programs (staff, transportation, vehicles) ²⁴
Social	Lack of commitment to disease control by local authorities ²² Reorganization of health services with new responsibility for municipal government ²² Politics plays central role in the health sector ²² Lack of people's trust in politicians and lack of belief in social and economic leaders ²² Lack of inter-sector approach to social development and problem-solving activities ²² Lack of medical care for persons with the disease ²⁴ Lack of prenatal follow-up of the disease in endemic areas ²⁴
Cultural	Whether community organization is dependent on external agents ²² Community participation in prevention and health promotion activities is dependent on health authorities, without considering the community's preferences and priorities ²² Large number of traditional healers, as the first choice of care before the hospital or health post ²² Lack of municipal funding for health; health system centralized ²⁴

employment, access to and utilization of natural resources, migratory flows resulting from impoverishment in given regions, etc.) (Tables 4 e 5).

The social dimensions ^{22,23,24} were a broad group and in some cases were close to the economic ones. They related to family and community social organization; disease-related social stigma; disease-related decision-making in the family by women; centralization by the Ministry of Health of decisions related to the local level; community organization to prevent disease; participation in decision-making and formation of cooperatives; access to education, health services, and housing; migratory movements; omission by the public sector; and loss of community trust in decision-makers, among others (Tables 2, 3, 4, and 5).

The cultural dimensions ^{22,24} related to a wide range of aspects: perception of disease; cultural changes and shocks resulting from migratory movements; knowledge, beliefs, and practices actions that increased or decreased the disease; uses of housing; dependence on external agents for community organization to combat the disease; and differences in cultural norms in different ethnic groups (Tables 2, 3, 4, and 5).

The dimensions related to the *disease in the ecosystem context* are mixed with all of the above, since they related both to ecosystem changes as well as economic, social, and cultural ones. They involve forms of social and cultural organization at the household, peri-domiciliary, and community levels, favoring the vector's presence and proliferation (individual and residential levels); characteristics resulting from ecological changes in the location and region, favoring the vector's presence and proliferation (from the local to the regional level); socioeconomic characteristics favoring poverty and combined in turn with ecological changes, contributing to increase the disease, more specifically in Tables 2 and 3.

The last group of dimensions was limited to the *impacts of interventions related to the ecosystem context* ^{23,24} and can be classified in two groups: (1) interventions aimed at reducing or eliminating conditions favoring the vector in the community, involving the use of chemical products along with programs to control the disease and plans to improve rural housing and in some cases to group the housing in defined areas (Tables 2 and 3) and (2) economic interventions favoring changes in local community organization

Table 5

Aggregation: regional/national/global – dimensions/scales and variables present in studies adopting ecosystem approaches.

Dimension	Scales of integration Regional/National/Global
Environmental, ecological, and/or ecosystem	Climate (rainfall, temperature, humidity) ^{22,23} Degree of ecosystem conservation ²⁴ Ecological balance/imbalance ²⁴ Macroeconomic projects ²⁴ Temporary crops ²⁴ Makeshift buildings in grain areas ²⁴ Vector population increase during hot seasons ²⁴ Quality of health system ²⁴ Seasonal variations ²⁴ Predominance of subtropical climate ²⁴ Environmental changes ²⁴ Rainy and flood seasons ²⁴ Economic interests in macro-projects ²⁴ Pattern of vegetation ²³ Presence of transmission foci ²³ Study site's geographic location and climate ²³ Ethnic and cultural characteristics of local population ²³ Climate changes (El Niño, La Niña) ²³ Global warming ²³ Global economic crisis ²³ Changes in the region's climate patterns, affecting agricultural practices and people's behavior ²³ Increased poverty in the developing countries ²³ Decreased financing of the health sector with reduction in disease control activities ²³
Economic	Lumbering by multinational companies ²² Population expelled from certain areas, resulting in migration and new settlements ²⁴ External contribution to program development ²⁴ El Niño ²² Low crop prices ²⁴ Flaws in alternative programs (starting with production) and prices, contributing to major migratory movements to urban areas ²⁴ National Agricultural Revitalization Plan ²⁴
Social	Migration from rural areas ²² Changes in health services financing ²² Situation of municipalities (prevalence of infestation and population serology) ²⁴ Health priorities ²⁴ Disease control as a decision by the Ministry of Health ²⁴ Improvements in the National Housing Plan ²⁴
Cultural	Origin of local population (African-descendent, indigenous, etc.) ²² Decentralization of vertical programs ²² Health sector reform ²² Differences in cultural norms between different ethnic groups ²⁴ Peasant farming culture still exists in large areas of the country ²⁴
Diseases in the ecosystem context (socio-environmental system)	Primary agricultural activity with low yields and poorly marketed products ²⁴ Migration to new settlements with endemic expansion ²⁴ Period of acute cases of the disease ²⁴ High temperatures contributing to increased vector production in the year ²⁴ Region is appropriate for coexistence of vector and wild animals (reservoirs), making the individuals at greatest risk have to work in or cross the forest for some reason ²³ Changes in rainfall patterns affect vector behavior and disease transmission ²³ The disease primarily affects people in the poorest countries ²³ Poorest countries lack resources to invest in disease prevention ²³

(continues)

Table 5 (continued)

Dimension	Scales of integration Regional/National/Global
Impacts of interventions related to the ecosystem context	National plan to improving rural housing ²⁴ National program to control diseases ²⁴ Development of regional development poles ²⁴ Environmental management ²⁴ Improved quality of roads ²⁴ Prioritization of programs for access to water for human consumption, gas, and electricity ²⁴ Generation of work alternatives to avoid people's exposure ²³ Stop global warming ²³ Redefine government health care policies ²³ Recruit more aid from the international community ²³

by creating regional development poles (including access to services like fresh water, electricity, and gas) and generation of work alternatives to avoid greater exposure to vectors (Table 5). At the global level, the interventions involved the redefinition of government health care policies, reduction of global warming, or increased aid by the international community (Table 5).

The articles, particularly those focused on the ecosystem approach to health, although limited in terms of their treatment of information pertaining to the attributes described in the ecosystem health approach (even those relating only to ecosystems services), proved capable of combining a set of diverse information and to a certain extent managed to demonstrate the interfaces between goods and services in the various ecosystems and their interfaces with economic, social, and cultural aspects. The ecosystem health approach helped contextualize these attributes. The main limiting factor was that although the articles cited other scales, they failed to work with them in a linked way and were focused on the local scales.

Formulation of institutional and policy changes

According to this second premise, an ecosystem approach necessarily involves the formulation of broad public policies and more effective institutions to implement them. The basic idea is that once the problem is known by collecting various types of information, this knowledge should be connected to the relevant action. This involves formulating a set of policies or measures – legal, economic, financial, institutional, and social interventions – that reduce or eliminate the direct and indirect impacts on the ecosystems and that directly and indirectly affect human health and well-being ^{1,2}. This basic idea is present in the two focuses discussed in this article, the ecosystem

health approach and the ecosystem approach to health.

Of the five articles analyzed, those by Rojas ²³ and Sosa-Estani et al. ²⁵ focus on the diagnosis of environmental problems, without proposing institutional changes or even formulating public policies to prevent or control the problem.

Due to their richness in connecting the diagnosis to proposals for institutional changes and public policy-making and the proposals themselves, the other articles will be analyzed in greater detail, since they provide material and inspiration for other studies with ecosystem approaches.

The paper by Rojas-de-Arias ²⁴ was the most complete in this sense, as part of a project aimed at analyzing three strategies for Chagas disease prevention (insecticides; housing improvement; and a program combining improved housing and insecticides) and using the results to foster better public policies to control the disease. The strategies were proposed on the following scales in the ecosystem: (1) residential – elimination of vectors using insecticides and the vector's microhabitat through housing improvements; (2) community – elimination of the vector in the community by massive use of insecticides in the peri-domicile and domicile and improved housing; (3) regional – national housing improvement plan and national Chagas disease control program; and (4) global – improved environmental management of farm produce access and marketing routes and electricity, water, and gas supply programs. The article considered strategies both at the various levels and in different dimensions (cultural, social, and economic). For example: (1) weaknesses at the municipal level involving lack of local health institutions and the limitations of a centralized health system, seen as a cultural dimension); (2) lack of medical care at the municipal level for Chagas patients and lack of prenatal care for pregnant women with Chagas disease in

some areas, considered a social dimension; (3) the need for Chagas disease control to be a Ministry of Health decision and for housing improvements to be incorporated into the housing plans, considered a social dimension.

The paper by Carrasquilla²² analyzed malaria control in the urban context, highlighting public policy-making for expanded control and prevention, considering the capacity of institutions to lead them. Primary health care was the underlying strategy adopted by the proposal, with actions focused at the local community level. The strategy discussed: (1) the precarious nature of local health services for providing diagnosis and treatment, proposing the reorganization of these services with new responsibilities for malaria diagnosis and treatment as a local government task; (2) the need for greater coordination of control activities between government agencies (at the national, state, and municipal levels), non-government organizations, and communities; (3) the need for an inter-sector approach to social development, crucial for reducing malaria exposure and incidence.

In the study by Murray & Sánchez-Choy²¹, the objectives and methods were designed to create a participatory research environment in order to ensure that the results would guide the community's action plans and the development of public agricultural and health policies. In the eight communities, community action plans were developed on the basis of the research results and local health indicators, identifying ecosystems management strategies allowing diversification of the local diet, increased food security, and relief of health problems.

Public participation in management

The WRI report¹ sees public participation in ecosystem management, especially by local communities, as an essential element. In the ecosystem health approach, public participation is considered important, but is not developed as an integral element of the methodology. The researcher is the key figure formulating hypotheses and analyzing the results. Meanwhile, in the ecosystem approach to health, public participation is considered an integral element. The researcher seeks to involve the various stakeholders in formulating hypotheses and analyzing the results, from the perspective of social and collaborative learning processes between experts and local social actors leading to adaptive management of problems.

The article by Sosa-Estani et al.²⁵ did not involve any direct participation by the public or local community in the research. In three other articles, local community participation took

place during the development of targeted local prevention strategies focused on education. In Rojas-de-Arias²⁴, participation took place at the family level, when at least one member of the family agreed to participate in the training for housing improvements needed to prevent Chagas disease. In this article, community participation occurred in the villages by organizing meetings to encourage local involvement by training volunteers for educational work and involving local health institutions in the project. In Carrasquilla²², community participation took place during the elaboration of educational materials and the production and distribution of mosquito nets to prevent malaria. At the end of the paper, the author recognizes that the research team was not successful in involving local actors, especially the local politicians and authorities, despite recognizing the importance of such participation.

The article by Murray & Sánchez-Choy²¹ is the only one reporting on participation by community members as inherent to the methodology. In this study, community members participated actively from the data collection phase onward. This broad participation beginning in the initial stages, closer to the ecosystem approach to health, served as the basis for promoting a broad dialogue among community members and launched the establishment of an environment in which the community can organize and plan an action platform for future problem-solving.

Final remarks

As stated in the introduction, the principal objective of the current article was to contribute to the development of ecosystem approaches in the Latin American context. We have thus sought to raise some issues and reflections that contribute to this process.

It became evident in the first section that there is still a limited scientific output in the form of articles attempting to deal with the interface between ecosystems and human health, with even fewer attempting to integrate this interface through the development of ecosystem approaches to health.

Second, the overall term "ecosystem approaches" entails important differences. The ecosystem health approach is efficient in its communicational thrust by using the metaphor of ecosystem as a patient. It allows raising the awareness of a large segment of the population concerning the interrelations between health and the environment. However, this same metaphor tends to limit the understanding of health to the predominantly biomedical aspects. In ad-

dition, although the ecosystem health approach is concerned with defining four dimensions, including the socioeconomic, it does not clearly demonstrate how to deal with them in an integrated way, thus maintaining the society/nature dichotomy. However, it does make strides in proposing attributes to be investigated in order to evaluate the health of ecosystems, by defining the eight fundamental criteria. These criteria have great potential to become ecosystem indicators for evaluations, diagnoses, and monitoring strategies.

However, in order to further develop these criteria as indicators, there are still barriers that need to be overcome in the Latin American countries both in terms of the amount and quality of available data, which end up limiting the potential to gather various types of information, as stated by the WRI¹ and verified in our analysis of the articles, demonstrated in Tables 2, 3, 4, and 5. In our assessment, the Latin American countries face four major obstacles for gathering various types of ecosystem information: (1) the limited availability of ecosystem data as compared to social or economic data; (2) data and measurements that are ideally specific for a given ecosystem display limitations for extrapolating to other scales (bio-regions, eco-districts) and do not fit easily into the political and administrative boundaries of municipalities or states that underlie the vast majority of available data and information³⁸; (3) institutional weakness (absent or precarious human, technical, and financial resources), resulting in absent or discontinuous ecosystem monitoring programs, with low quality of available data; and (4) difficulty in determining ecosystem health values or states as benchmarks, since this often involves subjective judgments about what should be considered “normal” or “acceptable”.

Other relevant differences between the ecosystem health approach and the ecosystem approach to health include the formulation of political and institutional changes, as well as public participation. These two aspects are more present in the ecosystem approach to health, which has had more influence on the research in Latin America, as discussed above.

Interestingly, the articles analyzed in the third section of the current article, which proposed changes and formulated policies, were nearly all focused on the residential or community scale, reaching the municipal scale at most. Even articles that included the global scale²¹ did not move forward on issues acknowledged since 1986 in the Brundtland Report³⁹ and that were present in the United Nations Conference on Environment and Development (Rio 92)⁴⁰, like proposals on the need for changes in institutions operating

at the regional or global scale (United Nations Environment Program, World Health Organization, International Bank for Reconstruction and Development, World Bank, International Monetary Fund, World Trade Organization, etc.) and whose decisions affect the local level, as well as interventions for reorienting global policy and the global economy (which are known to contribute to deepening poverty and generating global problems, like global warming and loss of biodiversity).

In relation to public participation, of the five articles analyzed in the third section, participation was quite limited in three^{22,23,24}. The study by Murray & Sánchez-Choy²¹ was the only one reporting on public participation as inherent to the research methodology.

Although public participation is crucial to implementing ecosystem approaches, it becomes quite complex to the extent that it involves great diversity and value conflicts. Much more than the intellectual competence of the social actors for the normative implementation of the technical options, it is the compatibility of the value system that allows the formulation and definition of the problems and the subsequent adherence to rules and procedures to be implemented in the responses to such problems. Still, since a community's value system depends heavily on the local social context, it is difficult to generalize and manage, especially in the contexts of poverty and social inequality characterizing Latin America, where survival issues often override those pertaining to improved environmental quality or even the integrity of ecosystems.

Thus far, we see a trend for ecosystem approaches to health to be more prevalent in Latin America, although most such approaches show limited development in their formulation management and public policy strategies, especially in terms of public participation. Progress in studies with this approach requires further development of these aspects, in addition to a better definition and formulation of the variables and a better link with the regional and global scales. In addition, the series of reports that are now becoming available through the United Nations in the global program *Millennium Ecosystem Assessment*² since 2005, including regional evaluations and studies on the relationship between ecosystems and health, should tend to strengthen perspectives in Latin America that identify more with the ecosystem health approach, since they heavily prioritize the evaluation of ecosystem attributes, especially changes in ecosystem services, to the detriment of social participation processes ranging from problem understanding to the search for solutions.

Resumo

As grandes mudanças ambientais que vêm se acentuando nos últimos dois séculos e que afetam a saúde humana exigem o desenvolvimento de abordagens científicas integradas, participativas e que resultem em proposições de mudanças institucionais e nas políticas públicas. O objetivo deste artigo é oferecer elementos para uma reflexão sobre uma linha destas abordagens integradas, os enfoques (eco)sistêmicos, na realidade latino-americana. Para alcançar este objetivo, realizamos breve descrição do quadro atual de produção científica no âmbito da Saúde Pública sobre ecossistemas e saúde humana na América Latina; descrevemos e comparamos as duas vertentes que se encontram na base do debate teórico e metodológico sobre os enfoques ecossistêmicos; analisamos os trabalhos empíricos que adotaram enfoques ecossistêmicos produzidos por pesquisadores da América Latina ou relacionados a países do continente. Os resultados apontam para uma pequena produção científica que considera a interface ecossistemas e saúde humana, sendo ainda bastante incipiente no que se refere aos aspectos referentes à participação e à formulação e implementação de mudanças institucionais e nas políticas públicas.

Ecossistema; Saúde Ambiental; Saúde Pública

Contributors

C. M. Freitas planned and organized the literature review and systematization and analysis of the available material, besides heading all the stages in drafting the article. S. G. Oliveira and G. E. Schütz participated in the planning and systematization of the literature related to the ecosystem health approach and ecosystem approaches to health in Latin America. M. B. Freitas and M. P. G. Camponovo contributed to the systematization of the literature related to the ecosystem health approach and ecosystem approaches to health in Latin America.

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