
**ENVIRONMENTAL DESIGN WITH AN INTERDISCIPLINARY
APPROACH. TWO CASE STUDIES FROM MEXICO**

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SUMMARY

The relationship between environmental and interdisciplinary design is analyzed in the framework of research relating to two case studies in Mexico. Having identified a trend towards generating interdisciplinary knowledge in Mexico to deal with the ongoing environmental crisis, the concept of environmental design and interdisciplinary research is discussed, particularly from

the viewpoint of complex systems. Two case studies, related to habitability and regional development, are presented. Finally, a number of considerations are offered about the challenges facing interdisciplinary research in environmental design, in the context of Mexican institutions.

Introduction

The challenges that the environmental crisis and the many roles, values and processes this presents for the environmental design (ED) of rural and urban spaces, i.e. for the territoriality of human settlements, has been recognized in terms of the varied policies and guides for action

at local, regional, national and international levels, as an attempt to provide a coherent, comprehensive, holistic and convincing scheme for managing and evaluating environmental planning from the perspective of regional analysis (Castro *et al.*, 2010). The agenda for international discourse concerning human development involves under-

standing the character of interactions between nature and society. Thus, the work and growing consensus regarding different methodologies and philosophies pertaining to the natural and social sciences has been essential for promoting interdisciplinary collaboration and an understanding of the relationship between human activity and environ-

ment (Phillipson *et al.*, 2009). Consequently, the research world has been required to develop appropriate interdisciplinary methodological frameworks in order to study and solve habitability, thereby provoking a great debate concerning the meaning of interdisciplinary discussion and how this approach can be promoted. An interdisciplinary

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DISEÑO AMBIENTAL CON ENFOQUE INTERDISCIPLINARIO. DOS ESTUDIOS DE CASO DE MÉXICO

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RESUMEN

Las relaciones entre diseño ambiental e interdisciplinarian son analizadas en el marco de investigaciones relacionadas a dos casos de estudio en México. Tras identificar una tendencia a la generación de conocimiento interdisciplinario en México a fin de enfrentar la actual crisis ambiental, se discute el concepto de diseño ambiental e investigación interdisciplinaria,

en particular desde el punto de vista de sistemas complejos. Se presentan dos estudios de caso relacionados a la habitabilidad y el desarrollo regional. Finalmente, se ofrece un número de consideraciones acerca de los retos encontrados por la investigación interdisciplinaria en diseño ambiental, en el contexto de instituciones mexicanas.

DESENHO AMBIENTAL COM FOCO INTERDISCIPLINARIO. DOIS ESTUDOS DE CASO DE MÉXICO

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RESUMO

As relações entre desenho ambiental e interdisciplinar são analisadas no contexto de investigações relacionadas a dois casos de estudo no México. Depois de identificar uma tendência à geração de conhecimento interdisciplinar no México a fim de manejar a atual crise ambiental, se discute o conceito de desenho ambiental e investigação interdisciplinar; em particular

desde o ponto de vista de sistemas complexos. Apresentam-se os estudos de caso relacionados à habitabilidade e o desenvolvimento regional. Finalmente, se oferece um número de considerações sobre os desafios encontrados pela investigação interdisciplinar no desenho ambiental, no contexto de instituições mexicanas.

approach spanning the social sciences and humanities may have an important role to play in providing a knowledge base and the inspiration for new policies that promote resilience, sustainability and social change (O'Brien, 2010).

A number of instances where ED can be approached from an interdisciplinary angle and implemented through institutional research are discussed herein, especially to the extent that the challenge presented by an interdisciplinary approach is deemed to fulfill an exercise that must be established and understood within the institutional framework and in terms of the practice of daily research tasks. This essay addresses problems related to generating interdisciplinary knowledge involved in research practices for ED. The concern focuses on the need to develop this kind of research in Mexico and how particular situations emerge requiring this type of knowledge, above all in relation to regional development within the framework of various natural and social sys-

tems. It is considered that discussions about the construction of socio-environmental knowledge require bringing together a number of interdisciplinary approaches in order to promote the collaboration and institutional learning necessary for coping with the complexity and uncertainty surrounding: problems related to the quality of life of populations and their territories, the use and management of natural resources, and socio-economic processes for appropriation and conservation of resources, among others. Also, this interdisciplinary approach should be able to deal with the dilemma of how the different ways of expressing regional socio-environmental problems are defined at different levels of organization and on different scales through social, technological and natural dynamics.

The essay is divided into four sections. The first identifies the trend towards producing interdisciplinary knowledge in Mexico in the light of the current environmental crisis. The second refers to a

concept of ED and interdisciplinary research, particularly focusing on complex systems as a methodological framework for knowledge generation. The third one describes two proposed case studies for interdisciplinary research in Mexico, related to habitability and regional development. Finally, the fourth section presents a set of considerations about the challenges facing interdisciplinary research in the context of ED in institutional contexts in Mexico.

The Environmental Crisis and Generation of Interdisciplinary Knowledge in Mexico

The complexity of knowledge generation in Latin America is revealed in a series of historical trends that reflect their heterogeneity in terms of improving the quality of life of populations and providing welfare, equality and equity. These aspects are viewed according to each region where there is increasing collaboration and cooperation

with science, education and global culture. However, recently, systems for knowledge generation in this geographic area face new challenges in terms of complex problems and new global threats, such as climate change (World Bank, 2010). Likewise, in the context of the unequal application of market regulations and rules imposed on international, regional and local trade, inequities in terms of quality of life and habitability, access to food, health, clean water and other resources for poor people with less resilience are exacerbated. Against this backdrop of continuing environmental deterioration that impacts our societies is the fact that, in 2007, 34% of the population in Latin America and the Caribbean lived in conditions of poverty and 13% lived in extreme poverty (United Nations, 2009), indicating the need to implement a dynamic evaluation of the interrelationships between natural environmental factors (bio-geophysical), humanized environmental factors and socioeconomic ones, relating

to those who employ ED.

Progress in the study of socio-territorial changes in the face of bioclimatic distortion at different territorial levels: local, municipal, state and regional, still remains unclear, especially as it relates to the regional quantification of the costs of climate change and for devising efficient development strategies (CEPAL, 2009). There is also a need to address the mitigation and adaptation of these effects, particularly when they exceed the boundaries of natural variability in ecosystems and the habitability of human settlements. For example, in economic terms, it is estimated that the cost of climate change impacts in Mexico for the year 2100 will be three times greater than the cost of mitigating 50% of national polluting emissions (United Nations, 2010). Therefore, adaptation to bioclimatic changes such as processes of adjustment to anticipate the adverse impacts of such changes in order to reduce vulnerability now, form part of the design of environmental and economic policies and the definition of strategies that regulate the interaction between institutions, sectors and stakeholders, who act as decision makers at different government levels (Eakin and Lemos, 2006). This implies that promoting institutional and operational capacity to carry out research projects and innovation at the regional level should be considered, as a way of evaluating local production systems. This becomes a long term opportunity to combine processes for economic, technological, social and ecological improvements towards sustainability. In this regard, the comprehensive assessment of the possibilities of sustainable development in Latin American regions, along with emerging types of organization for scientific, technological and humanistic research have to resort to different temporal and spatial scales, as well as to different levels of theoretical

comprehension for interdisciplinary knowledge. For the emerging Latin American agenda, social sciences may be crucial for providing understanding of the complexities and social contrasts in this variegated landscape (Vessuri and Sonsiré 2010).

In the light of the dilemmas relating to the environmental crisis facing Mexico, concepts of ED and sustainability are useful for referring to sets of systems of human-environment interaction, which include, for example, territoriality, food security, human health, the value of ecosystems, water, economics, human resources and the environment, among other factors. Thus, generation of knowledge in Mexico is restricted by a strong dependency on geographical, natural and social factors, and either absent or weak regional institutional support systems, which are a reflection of the limited capacity of the national government to integrate interdisciplinary research and regional analysis within sustainable development strategies. As Mexico is a country with vast natural, cultural and institutional diversity, there is an apparent need to identify regional problems and opportunities in order to strengthen social capacity for learning science, technology and innovation, as factors contributing to competitive capacity and progress. In this sense, contemporary environmental issues in Mexico are complex and are expressed in multiple processes of socio-ecological deterioration; equally evident at local, regional and national levels. Urban growth and industrial production, the increasing devastation of the natural environment, increased poverty, pollution of soil, water and air, as well as a decline in biodiversity are different aspects of the same crisis, inherent in the nature-society relationship (Sarukhan *et al.*, 2009).

However, although in Mexico, in the last three decades, addressing environmental

problems has been tackled from different disciplinary perspectives: academic, institutional, civil and sector oriented, there is still a significant lack of spaces for research comprising interdisciplinary studies, based on the analysis of complex systems, to translate knowledge into concrete proposals for sustainable regional development. For example, there is evidence that Mexico still needs to become familiar with various areas of emerging research, demonstrated by the fact that only 10% of research concerns environmental sciences (Kostoff *et al.*, 2005). As a result, other alternative research networks are working on building a more comprehensive concept of the environmental crisis, where the overlap between nature and society represents the axis of study. Thus, the outcome will be an eco-centric or deeply ecological, holistic, interdisciplinary and trans-disciplinary focus, which deals with regional reality for what it is: a complex problem. In these types of collective collaborative projects, knowledge is incremented by operating networks and partnerships between academics or researchers, who seek interrelationships and interdependence between environmental, territorial, social, economic, cultural, political, scientific and technological areas. This has helped to lay the groundwork for discussion and to develop a new vision of future society, based on an eco-centric point of view and from the perspective of economic-environmental development, where environmental sustainability and social equity have their place.

ED and Interdisciplinary Research Focused on Systems

It is recognized that in the design field there are different types of knowledge and that an epistemological relationship exists between design disciplines aimed at increasing knowledge (Carvalho and

Dong, 2009). This implies competition between a varied range of types of knowledge, methodologies and historical techniques related to culture, politics, economics, education, communication, psychology and biology. These are viewed from the perspective of the functionality, communicability and creativity of those who produce, modify, use, occupy and inhabit objects and spaces, and both real and virtual images used to achieve a certain degree of comfort (Chiapponi, 1998). It is possible to approach design from the aspects of science, technology and art that can cover the evolution of societies and organizations, as well as the functions and uses of spaces and public and private objects. In those professions related to ED, value systems are assigned to the categories of social and environmental aesthetics (Thompson, 2000). There is a vast literature invoking an interdisciplinary approach as a topic for theory, research, education and politics. Jacobs and Frickel (2009) report that the book by Frodeman *et al* (2009), which covers physics, life sciences, ethics and design itself, confirms the premise that the academic interest in the interdisciplinary approach is very widespread.

In recent years, the considerable increase in research on design has expanded the boundaries of the practices and domains of design itself, so that it has been drawn into the complexity of an interdisciplinary approach, where various disciplines and professional activities are articulated (Michel, 2007). Although the human being is at the center of the object of study design, possibly its occupation of this space refers to their need to make it habitable. In this sense, designing this area of human knowledge is essential, because it responds not only to the need for habitable infrastructure resulting from human endeavor, but also for humanizing or socializing conditions concerning envi-

ronment and quality of life. This is because these conditions are expressed and their dimensions fit within a space time framework. Time and space, as physical-symbolic dimensions are indissoluble within the plane of human existence, which is tantamount to being in the world according to a generic classification defined by sites or environments and physical or virtual objects. Habitability is the required, structural and defining element of the design in the sense that it improves our visual surroundings, making the world intelligible and in fact improving quality of life (Costa, 2003), whilst at the same time providing information and improving the objects and spaces that we use. Thus, comfort is a mental-cognitive (introspective) representation of well-being, applicable to any design discipline.

Environmental design in particular may complement the work of multiple strategies for research activity that have developed during the last twenty years under the influence of the deep global reflection on the relationship between humans and their habitat, and about the environmental crisis and its effects on natural resources, which has been the model for contemporary development. However, the design theme from the perspective of environmental sciences is somewhat ambiguous because of its technical-scientific emphasis and may be synonymous with concepts such as environmental planning or variants of what is known as ecological ordering and spatial planning (Potter, 2009). Today, there are a variety of approaches defined by the term 'environmental design', and these include sustainable design, sustainable architecture, eco-design, sustainable ED, etc. However, most of these approaches are still very limited in terms of incorporating environmental issues, such as the professional practice of planning buildings, cities,

products (Maciel *et al.*, 2007) and the architectural design of physical environments, in some cases in an inter-generational context (Kaplan *et al.*, 2007). This refers to the idea that design activities and the organization of research aligned with this approach should re-define their identities and the cultural role that they play (Vezzoli and Manzini, 2008).

In particular, the idea has been affirmed that the construction of design theory requires systematic thinking about the processes and procedures for approaching an object, finally resulting in knowledge (Basa, 2009; Friedman, 2003). As far as an interdisciplinary approach is concerned, the concept of ED has two major sources of inspiration: 1) the objectivist, who attributes the things we use as human beings to the material they are made, of soil, wood and paper, among others, and 2) the subjective, which originates in the minds of individuals and is manifested in the assignment of values and preferences, either real or virtual, for the use and occupation of these same objects and spaces. The complex systems approach can take habitability to mean the result of a series of connections between and within a) systems of objects and spaces (biophysical) based on theories of ecology, physics, engineering, among others; b) systems based on human (subjective) values, based on theories of psychology, sociology, economics, etc.; and c) a set of interactions between the above that can be referred to as the connective structure in the field of interdisciplinary knowledge, relating to ED.

Thus, habitability in the case of ED can be considered to comprise a complex system composed of two sub-systems: the objective one, which can be called biophysical, and the subjective one, known as the process of individual decision making or culturally based assessment system (Chaudhury and Mahmood, 2008).

With reference to this and from the perspective of ED, habitability in this context refers to ways of life and in this sense we are talking about history, space and time, and also about scale. Today, it is important to reestablish these forms of integration, separation or communication, from architecture and cities and from transitional spaces, through tension or connection with these identities. In this sense, the intermediate space between the various objective, architectural, urban, regional, and global scales is defined as a transitional space that involves tension or connection, sustained on the dialectics of inside-outside, house-city, public-private, etc.

Habitability and Regional Development. Analysis of Two Case Studies in Mexico

This team initiated research activities in 2000, with the participation of architects, land use planners, economists, anthropologists, agronomists, biologists, geographers, designers of human settlements, industrial designers, sociologists and agro-ecologists. The main methodological focus took an interdisciplinary approach to problems of habitability and sustainability for regional development, viewed from the perspective of systems, including an analysis of natural systems modified by human society as a result of the construction of habitable spaces, modification of energy systems, changes in land use as well as extraction of materials and production of waste. Scientific, technological and social analysis concerning the overlap of natural systems and social systems requires a highly complex effort, due to the huge number of variables, disciplines, stakeholders and dynamics related to spatial-temporal changes. Interdisciplinary research projects have considered that the application of two main methodological tools is a priority. They are: a) that related to public par-

ticipation and the institutional operators who live and direct systems for design and regional environmental management; these involve processes for diagnosing problems, applied research activities to address these as well as monitor any implemented solutions; and b) that related to management and integration of information, enabling researchers, population and institutions to participate in decision making within the regional framework. In this context, there are aids such as geographic information systems, online interactive databases and multi-criteria planning models, all aimed towards developing future scenarios.

In this sense, research experience has created an interdisciplinary conceptual-methodological framework for design, requiring an understanding of the natural (bio-geophysical) and humanized environment (space for the production of social relations), where the interaction between habitat and environment is made evident, as well as the necessary qualities for habitable and sustainable regional development. The following section presents the two most recent case studies that this research team has developed under an interdisciplinary approach.

Regional development, resources and ED in the Papaloapan Basin

This case study aimed to study the problems arising from the crisis of sustainability for regional development in the Chinantla Valley, Oaxaca, Southeastern Mexico. The already long history of environmental degradation in the region has been compounded by recent trends in socioeconomic reorganization related to effects caused by urbanization and territorial impacts from economic, cultural and educational phenomena, which exceed levels of comprehension and explanation. These conceptual, meth-

odological, technological and practical problems advance much faster than effective responses and solutions. In particular, the problem of habitability affects large natural and urban areas, as well as small more personal spaces, such as housing. In this sense, the problem of habitability is identified as a social and economic problem, requiring design and environmental management.

The Chinantla region is located in the foothills of the Sierra de Juárez and is part of the Papaloapan River basin. The region consists of 14 municipalities and 258 villages, with an area of 460000ha. The municipalities of Chinanteco are divided into three eco-geographical sub-regions (high, medium and low). The altitude ranges are conducive to a diverse and complex environment, both physically and environmentally, ranging from areas of temperate coniferous forest, above 3000masl, to tropical forests in the lower and mid-ranging area, with transition areas consisting of cloud forest. On these slopes height variations ranging from 100 to 3000masl are covered in distances as short as 40km. The region is typical of the humid tropics and in terms of area, it is the third largest rainforest in Mexico and also the best preserved. The average annual precipitation is ~3845mm/year. Annual average temperature is 25,2°C. The water system in the region has been modified, as besides human consumption there is the effect of agriculture and industry, principally the Tropical Beer Company, the Adolfo López Mateos sugar mill and the Tuxtepec paper factory. Access to water has been and is a strategic factor for regional development because it not only sustains the local environmental balance, but also the processes of population growth, production, manufacturing and services. The presence of 73 *ejidos* or communal landholdings (5781 *ejido* owners) and 20 farming communities

(4257 communal landowners), along with a predominantly indigenous population who maintain their traditional institutions has made it possible to keep some balance between settlement patterns and natural resource management. However, the introduction of rural modernization policies and their consequences for production procedures and regional technological systems, particularly in the low and mid-altitude regions, where high population density and the breakdown of habitability patterns caused by changes in land use (e.g. deforestation and increased pressure on natural resources with the production of sugar cane, rubber, tobacco and livestock) has created serious problems and conditions resulting in environmental degradation and socio-territorial dynamics vulnerable to regional climatic variations.

The main problems facing the region include: the absence of sustainable regional development models that take into account social and environmental dynamics and local production, deforestation, poor management of water resources and lack of environmental services, improvisation in self-construction of housing and local government buildings, lack of design for regional and local environmental projects that include habitability, and the abandonment of the farming sector on the part of young people.

As part of an interdisciplinary strategy for ED, a research hypothesis that considers such capacity for regional development is based on a model of socio-territorial diversity causing less impact on natural productive and habitable systems, leading to reduced vulnerability and a higher level of sustainability in development, thus permitting greater potential for adapting to the processes inherent in environmental and human settlements. The test for this hypothesis consists in implementing quantitative and qualitative analysis of the

concept of sustainable regional development and ED within a data set that accounts for economic, environmental and social factors. The main hypothesis can be understood in terms of the following questions: 1) What are the interrelationships that exist between socio-territorial diversity and capacity for sustainable development caused by the impacts of urban and architectural typologies in natural and productive systems? 2) How has the emergence of new regional scenarios in the light of urbanization changed the process of adaptation at the level of socio-territorial policies and adaptive responses on the part of the people, in terms of economic-productive strategies, use of local natural resources and habitability? 3) In comparative terms, how will regional development in the study areas promote diversity in terms of the environment, economic growth, quality of life and habitability?

In this sense, for an interdisciplinary research project to be relevant, it has to recognize that the main contribution of management and ED must take into account and provide social scientific knowledge regarding the following issues: 1) Urban ecology (ecological landscapes, social and physical spaces and natural technological resources and energy systems), 2) Habitat and environment (natural and living spaces, materials and technology systems, models for habitability and identity), 3) Regional development (territorial quality, social actors and urban dynamics, environmental impact, institutional strengthening, policy formulation and ED), and 4) Environmental education and communication (systems and technologies for organizing information, socio-environmental knowledge, education and environmental management.

In particular, the overall objective of the case study was to contribute to the generation, evaluation and dis-

semination of knowledge in design and environmental management, by means of socio-environmental models for rectifying the problem of habitat in the Chinantla region of Oaxaca. The specific objectives were: a) to sustain the thesis concerning the emergence of new scientific and social paradigms in terms of the study of the relationship between nature and society and between environment and habitat, b) to investigate and study the interrelationships between natural environmental factors (bio-geophysical), of factors in the humanized environment and of factors relating to the user of the ED; c) to analyze environmental conditions and their relationship to architectural spaces in order to establish the tenets of design focused on creating spaces and habitable and sustainable environments that fulfill the social, functional and expressed objective, promoting the efficient use of resources and systems; d) to develop methodologies and socio-spatial models for predicting the development of urban areas at different scales of intervention and vulnerability, based on sustainability and social cohesion; e) to evaluate the impact of current environmental and economic policies in shaping the geographical area of the Chinantla region, and to generate planning proposals and public policy in order to improve projects for urban revitalization and sustainable development, and f) to develop scaled eco-technological models for the region.

Contributions from interdisciplinary research and the usefulness of predicted results concerning aspects of regional development and ED for the Valley of Chinantla are:

1) *Better understanding of the convergence between ED, economic growth and regional development in Mexico.* Research should strengthen existing conceptual and methodological approaches for understanding

the use of resources, technological impact, energy systems, production practices as related to habitat, economic and political agents and scales of operations for regional development in the Papaloapan Basin.

2) *Better understanding of the factors that promote or inhibit regional development in the Papaloapan Basin.* In the short term, the proposed study must have the capacity to provide assessment and indicators relating to the sustainability of regional development through the identification of interactions between several bio-geophysical factors, including habitability, population, socioeconomic, political and institutional.

3) *Improved effectiveness of environmental policies for regional development in other basins of Mexico.* This kind of research should be able to identify design, planning and educational options as well as implementing environmental policy for making institutional decisions that will strengthen economic growth and regional development potential for other basins in Mexico facing similar economic and environmental constraints and, also, implementing development strategies in these habitable spaces.

Bioclimatic vulnerability and regional habitability. Implications for ED and socioterritorial policies in the Upper Basin of the Lerma River

In Mexico, human populations have historically responded to climate variability and different environmental (i.e. water shortages) and economic pressures (i.e. food scarcity) (Endfield, 2007). However, the consequences of these responses on natural systems have implied, for example, in the hydrological region Lerma-Chapala-Santiago, watershed degradation, loss of ecosystems, surface water erosion and gully cre-

ation, wind erosion, fertility decline, contamination, salinization and alkalization. Besides this, in the upper Lerma River, there has been an increase in poverty levels in human systems, socio-territorial transformation of geographic spaces, cultural habitat loss and increased migration. The region of the Upper Lerma River basin, in the State of Mexico, covers 5354km² and is made up of 32 municipalities. Agricultural land use, livestock and forestry occupy 86% of the area of study.

This project regards the region as the conceptual and analytical delimitation that includes processes and territorially structured socioeconomic interrelationships, biophysical environment, means of territory appropriation (taking into account economics, technology, social organization) and also institutions (Cotler, 2007). Consequently, once the study site had been chosen: the region of the Upper Lerma River basin, the following criteria were taken into account: 1) This region reflects socio-territorial changes in environmental integration and regional economic development, although their pace of endogenous development varies. 2) It manifests different patterns in terms of the incorporation of rural-urban areas into the mechanisms present in the macro-regional market. Each location depends on a specific geographical base. 3) The region is part of one of the most important watersheds in Mexico, the Lerma-Chapala-Santiago, which includes nine States of the country, is home to 17,7×10⁶ inhabitants and is the source of water for 15% of the Mexican population. The basin is an important agricultural and industrial region, as it comprises ~13% of the country's irrigated area and generates 9% of the GDP of Mexico (Wester *et al.*, 2008). 4) The Lerma-Chapala section is the context of marked urban, agricultural and industrial de-

velopment, with a high level of both surface and ground water contamination, high vulnerability to extreme events; natural resources and ecosystems are very damaged locally, and water problems are a source of inter-institutional and intergovernmental conflict, with little influence on the part of organized social participation in terms of definition of public policies. 5) Depending on specific local conditions, this region is likely to become an example of existing variations concerning concepts of economic, ecological and socio-cultural vulnerability in the face of the bio-climatic changes occurring in Mexico.

Major headway has been achieved in terms of understanding the environmental and socioeconomic principles for managing the Upper Lerma River, including information on sources of pollution, priority areas for economic rehabilitation, estimating the costs of environmental remediation, the integration of environmental protection in sector policies and the integration of socio-economic aspects within the framework of the principles of sustainability (Sandoval *et al.*, 2008). However, progress in the study of these social and environmental perturbations in local and regional contexts (i.e. the influence of climate on current building systems) continues to be vague concerning mitigation and adaptation to its effects, particularly when the limits of natural variability in ecosystems are exceeded. An attempt to apply fundamental research to address these problems requires understanding the integration of the human and biophysical dimensions of vulnerability and habitability.

Through an interdisciplinary conceptual and methodological approach, involving the integration of these socio-territorial dimensions of vulnerability in the region of Alto Lerma, research addresses the following requirements for knowledge genera-

tion: a) Characterization of the range of risk exposure to bioclimatic risks on a spatial regional scale, emphasizing particularly the indigenous population. b) Development of comprehensive strategies for the conservation and development of ecosystem services necessary for maintaining the region. c) Identification and prioritization of the bioclimatic risks that affect the habitability of different systems, territories and social groups. d) Assessment of socio-territorial vulnerability of different groups and the attribution of these differences in vulnerability to causes and effects. e) Information and decision-making processes for managing bioclimatic risks by different groups and socio-territorial spaces. f) Identification of policies, planning activities, proposals and effective bioclimatic strategies for implementing the processes of ED for the purpose of adaptation through the involvement of organizations and regional institutions.

This research conceived ED to be a planning process for tackling environmental issues, including the generation of alternative technologies for environment care and the design of activities and projects, among others. A comprehensive approach to the study of the impact of bioclimatic changes in these regions must dynamically register variations in local vulnerability and adaptive capacity. In particular, the processes for defining policies for socio-territorial development require an evaluation of the complexity of the alteration of the dynamics and composition of ecosystems, hydrological processes and human systems (Morehouse *et al.*, 2008), whilst the use of methodologies and models at the regional level are suitable for preparing agendas and development processes aiming towards sustainability (While *et al.*, 2010). These scenarios of environmental and economic

policy should be reviewed as institutional principles for the management of natural resources, not only referring to the existing vulnerability, but also within the framework of the severely critical impact of human activities on regional, rural and urban production systems (Suarez and Delgado, 2009) and the functioning of the ecosystems, mainly in terms of hydrological processes and landscape structure for watershed management (Antipov and Gagari-nova, 2009).

Therefore, interdisciplinary work and multi-level recognition requires identifying the changing bio-climatological scenarios of habitability, ecosystems of the landscape and regional social reform. Thus, institutional and operational challenges, as well as dilemmas concerning research practice and tasks for the social dissemination of knowledge, contributing elements of analysis for the design of policies aimed at reducing socio-environmental vulnerability and regional habitability in the face of bioclimatic changes to natural and human systems must be associated with the practice of environmental and economic planning.

Challenges to Interdisciplinary Research in ED

The growing influence and importance of interdisciplinary research as a method of studying socio-environmental problems is part of the construction of knowledge in Latin America and Mexico (CEPAL, 2009). In our experience, various participants and their corresponding scientific disciplines have directed attention to the construction of collaborative research projects in order to create a team of researchers who address the problem of ED, habitability and regional development. However, in this research concerning ED, there is still a serious problem concerning the difficulty

inherent in communication and collaboration between different disciplines, representing a particular form of social intelligence, which is necessary as an effective precursor for collaboration in research practice. It is considered that the maturity of interdisciplinary relationships helps the rich body of knowledge generated in areas of specialization, improving understanding of complex coordinative processes.

The formation of interdisciplinary knowledge and collaboration based on work teams are essentially overlapping concepts, but they are not identical. In this sense, addressing a complex socio-environmental problem that implies collaboration of themes and methodology often based on approaches employing different disciplines for their analysis, does not require as much the sum of disciplines or partners as, rather, their integration. For example, the development of eco-technology and habitability, and the bodies of knowledge which have sustained these, has its origin in the epistemological and methodological approach referring to the concept and issues of sustainable development. Thus, during the process of team collaboration, aimed at forming this new interdisciplinary knowledge, it is possible to respond to a new object of study, whether this be the analysis of interaction and interdependence on the part of social and environmental sciences or, in the best instances, from the sciences and arts and to architecture and engineering, all of which play a role in habitat development.

Likewise, as appropriate conceptual precision in our work team and research experience grew, the predominance of multidisciplinary focus has been avoided and can instead be described as design efforts from a combined set of disciplines in order to achieve a common goal. Here the contributions

from different disciplines are complementary rather than integrative. The disciplines make up the body of knowledge, concepts, methods and objectives used to study and think about phenomena and the questions associated with them. Thus, there is an attempt to prevent these concepts and methods being accepted by the research team, as a valid way of answering the questions pertaining to a particular problem. It has not been a premise that knowledge associated with a certain discipline should serve as a division from a normative perspective, which would restrict the activities of the team, in terms of instructions defining what should and should not be done. In this regard, one has to be conscious of the origin, foundation and knowledge concerning epistemological reflection related to the disciplines of the participants, and be aware that this can not be applied directly to the generation of knowledge, or rather not until the social conditions are established for epistemological control, i.e. a generalized exchange of available critiques (Bourdieu *et al.*, 1983).

An interdisciplinary approach depends on integration, not only of varying research methods, diverse conceptualizations and theoretical positions, but also of different assessments and approaches sustained in practice and in empirical knowledge related to ED. It serves its purpose for the construction of knowledge, for creating productive tensions in the dynamics of supplement, complement and criticism. The concept of interdisciplinary research in ED means that the information is integrated in terms of information, data, techniques, tools, perspectives, concepts and theories from two or more disciplines or specialized bodies of knowledge for improving fundamental understanding or for resolving problems that are beyond the

scope of a single discipline or field of research.

In our team, where there is a union between architects, economists, agronomists, land use planners and ecologists; interdisciplinary research has inherently become an activity for connection or interaction between disciplines, not only in terms of the varied types of knowledge, but also referring to the norms of each discipline for creating these, which has certainly complicated interdisciplinary activity itself. However, interdisciplinary activity is believed to be a process which brings together various members of a coordinated scientific team, involving members in activities that must be learned and that have naturally emerging results. As a result, when engaging in interdisciplinary research, it becomes necessary to adequately understand each of the disciplines but, also because of the very nature of a collaborative team, the research process becomes more attainable to the extent that it is concomitant with the implementation of work principles and team training, inherent to interdisciplinary research. This has allowed to accomplish, as a team, aims and goals of greater complexity than if they had been designed by and for a single individual, so the difficulty of the research is not in the content *per se*, but in terms of the type of interaction.

The type of interdisciplinary research found in ED, rather than being just a simplistic and technocratic approach for solving bio-physical-geographical problems becomes an exploration of new sources of meaning and understanding of extremely complex problems, such as habitability and regional development. Or in other words, it refers to the question of how to develop an evolving research process, developing at the same time a new epistemological framework that stems from deliberative and horizontal man-

agement of the interdisciplinary network. Our experience in research concerning ED has confirmed that with additional insight, owing to the social networks of team members, experience and information can be provided for generating new knowledge, by providing access to multiple research sources (Adams *et al.*, 2008), from which new prospects can be derived for change and explanation of problems of the socio-environmental reality in Mexico.

Final considerations

Interdisciplinary research is a team science owing to the complexity and amount of knowledge related to the great problems facing humanity. In particular, the issues of habitability, along with ED and management, require a platform for analytical explanation and interpretation that captures the relationships between socioeconomic and environmental systems, from a new perspective of understanding. This new epistemological scheme should emerge from scenarios involving the collaboration and integration of theories, methods and data. The coexistence of research approaches and processes requires mutual interpretations of interrelationships between various fields of knowledge from different disciplines (spatial planning, architecture, ecology, sociology, economics, design, agronomy, etc.), together with a coherent re-configuration of phenomena and problems to be dealt with, as described in the two case studies included in this essay. However, it is clear that at the heart of this conflict and tension between disciplines, we find the phases of collaboration and integration between work teams that present their own inherent problems and challenges to consolidation.

The methods used by an interdisciplinary research group or team to generate knowledge must often be

guided by organizational principles and regulated by a diversified conceptual structure with methodological and practical interdependence, to systematically address more complex problems, such as those relating to the socio-environment. Organizational modification of the teams for the construction of interdisciplinary knowledge is a priority in educational institutions, which offer space, time, promotional resources, development and recognition of this type of research, as in the context of public universities.

The challenge facing Mexico is to create knowledge networks within the framework of international cooperation to support and contribute to understand and to solve serious regional and national problems, as well as to develop interdisciplinary research communities in different institutional contexts and areas of knowledge, principally those related to environmental challenges. The promotion of policies for the management and conservation of the environment and for organizing regional habitability necessarily imply the design of strategies and activities for implementation and development of research in order to inform and support the policies themselves. In particular, it should respond to questions and problems arising from the nature-society relationship and define how social and environmental scientists should work together through networks of interdisciplinary work.

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